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CORRIGENDA - JOINT QUARTERLY REPORT NO. 3

These two pages, listing errors and corrections, should be inserted before the title page of JQR 3. With these additions, the document will then consist of 220 pages.

p. 110 (2nd paragraph)

For D_2, read D_T.

p. 124 (2nd paragraph)

For times, read minutes.

p. 134

Delete (AEROSOL CONDITIONS AND RESULTS)

For TEST RESULTS, read AEROSOL-CLOUD COVERAGE.

For (Area in Sq. Yds. Per Gram)
Particles per minute per liter,

read Area per Gram (sq. yd./gm) Within Indicated Dosage Isopleths (particle-minutes per liter).

For Med, read Mid (i.e., Middle).

E represents Estimated.

p. 135

2nd paragraph: For 2 1/2 and 1 1/2, read 2 1/2, 1 1/2, and 3.

For last sentence, 3rd paragraph, substitute
In all cases the areas have been adjusted for wind speed and the amount of material released [A(sq. yd.) x mph/gm] .

Delete 4th paragraph. (Figure V-21 was represented incorrectly. The comparison of Minneapolis and Salisbury tests will be the subject of a new figure in JQR 4.)

p. 136

Delete 1st paragraph.

53-9+MR-104

p. 151 (Fig. V-20)

Abscissa units are $\frac{yd^2}{gm}$ x mph.

Ordinate units are particle-minutes per liter.

p. 152

Delete Fig. V-21. (Revised figure will appear in Section III, JQR 4.)

p. 153 (Fig. V-22)

Ordinate units are yd x $\frac{\text{particle-minutes}}{\text{liter x gm}}$ x mph.

pp. 180 (Fig. B-4), 186 (Fig. B-10), 193 (Fig. B-17), 200 (Fig. B-24), 207 (Fig. B-31), and 215 (Fig. B-39)

Abscissa units are yd^2 x mph/gm.

Ordinate units are particle-minutes per liter.

pp. 187, 188, 189, 194, 195, 196, 201, 202, 203, 208, and 209 (release-point photos)

Photographs should not be considered to show exact disperser location or direction of cloud travel. Rather, each is a representative view of the vicinity in which the aerosol generation took place. Since the pictures were taken a considerable time after the test dates, surface conditions shown in the photographs are different from those existing during the time of the test operation. (See "Ground Cover" column in Table V-1, p. 134.)

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Copy 3 0 of 30, Series A

This document consists of 218 pages

CHEMICAL CORPS, U. S. ARMY

BEHAVIOR OF AEROSOL CLOUDS WITHIN CITIES

Joint Quarterly Report No. 3

January - March 1953

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C O N T E N T S

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LIST OF TEXTUAL ILLUSTRATIONS (Continued)

LIST OF TEXTUAL ILLUSTRATIONS (Continued)

I. SUMMARY

A. OPERATIONAL AND ADMINISTRATIVE PROGRESS

1. Winter Program in St. Louis and Minneapolis

Between January and March 1953, 18 temperature surveys, in addition to the 17 reported for the preceding quarterly period, were made in St. Louis preparatory to selecting a provisional site for studying aerosol cloud behavior. Though no measurements were taken of the vertical temperature gradient within the city, the associated raob sounding obtained at Columbia Airport is presented with each horizontal air temperature survey described in this report.

In Minneapolis, aerosol cloud study has been started, based on the results of 61 separate releases of fluorescent tracer material in four selected areas. Complementary information was provided from measurements of the horizontal and vertical temperature gradients, the St. Cloud raob soundings, and observations reported by auxiliary field meteorological stations before and during individual tracer tests. In addition, studies were made of the penetration of the aerosol cloud into structures to determine the ratio of inside to outside dosages obtainable. Penetration data were obtained from 29 sampling units placed in houses, and from 88 units located at various levels within a school building.

2. Field and Laboratory Operating Procedures

Detailed descriptions are given of the St. Louis and Minneapolis activities, in which 15 full-time and 233 part-time employees are currently engaged. Considerable attention is given to procedures for conducting mesometeorological surveys, including temperature traverses, wiresonde operations, and data analysis. Tracer test operations are also detailed, including test planning, preparation of equipment, aerosol generation, sampling, and filter analysis.

3. Instrumentation

The self-contained, portable filter sampling unit especially developed for this project embodies a number of desirable features and characteristics which are described in the current report. Also presented is the design of a suitable flow meter for use in conjunction with the unit. The wire-sonde equipment now in successful operation for obtaining vertical air temperature profiles is discussed from the standpoint of design and field operation.

B. PRELIMINARY EVALUATION OF WINTER PROGRAM

1. St. Louis Temperature Surveys and Aerosol Site Selection

Of the 35 two-meter air temperature surveys conducted in St. Louis since the inception of the current program, four surveys are fully evaluated. From seven selected isotherm charts, and the associated raob soundings and winds-aloft data, a characteristic temperature structure has been determined. As in other cities in which comparable studies have been made, highest temperatures are found in or near the built-up area, while lower temperature readings are obtained near the large parks or undeveloped regions. The horizontal temperature gradient, however, is much flatter in St. Louis than in Minneapolis. Though a considerable horizontal gradient is generally evident to the east of the downtown district, the gradient to the west-northwest is quite weak. The reproducibility of the temperature pattern seems likely, since the same gradient was obtained under varying weather conditions. The flatness of this gradient was the factor chiefly responsible for the selection of a five-square mile test area within the west-northwest region. The area, which is densely built-up and sparsely tree covered, includes the warmer downtown district that will be used as one test site and is large enough so that a number of one-square mile test sites of intermediate building density can subsequently be chosen.

2. Aerosol Cloud Behavior in Minneapolis

Preliminary evaluation of aerosol cloud behavior is based on results obtained from six tracer tests; comprising a total of 18 releases, which were conducted in Able Area. Except for one daytime operation, all tests were performed at night using a point-source operated for a five-minute period either from a vehicle or from a roof-top position.

From currently available data, three tentative conclusions may be drawn:

a. Under given meteorological conditions, street-level dosage patterns are reproducible in an essentially residential area.

b. The position of the point-source aerosol generator has little influence in the street-level dosage pattern; similar patterns are obtained when the source is located at a street intersection, on a roof top, or in the middle of a block. As a result, the point-source data may be combined to estimate the dosage-area relationship, which might be obtained from multiple-point or line sources.

c. Of the penetration studies conducted in residences and in the Clinton School, greater dosages were obtained in the basements of houses than in the upper levels; in the school building, however, there was little difference in vertical distribution of the inside dosages.

II. FIELD OPERATIONS AND MANAGEMENT

A. INTRODUCTION

Section II summarizes all field and laboratory activities for the current period for which The Ralph M. Parsons Company is primarily responsible.

Complete resumes of tracer tests conducted in Minneapolis, including related laboratory activities, and meteorological surveys conducted in Minneapolis and St. Louis are presented in tabular form.

The breakdown of tracer tests and meteorological surveys includes the man-hours expended on various phases of field and laboratory operations. Methods of procurement, training, scheduling, and use of part-time help for conducting field work are presented. This Section includes such aspects of field procedure as have been influenced by the cities and climate in which tests have been conducted and the availability and capabilities of manpower. Actual field operating procedures for conducting tracer tests are covered in Section V. The Section is concluded with a resume of test operations scheduled for completion during the balance of the contract period.

B. ADMINISTRATION

1. Organization

The organization of thirteen full time field office employees remains substantially as described in MQR 2, the only additions during the current period being a full-time typist and a full-time draftsman at Minneapolis. These two additions make a total of 15 full-time employees, with 14 at Minneapolis, and one at St. Louis.

There was considerably more activity during the current period in the part-time personnel hires and terminations. At Minneapolis the year started with 62 part-time employees, and during the following three months, some 174 new people were employed, and 55 were terminated, leaving the total number of part-time employees approximately 180 as of 31 March. As of 1 January there were 32 part-time employees at St. Louis, and during current period 29 additional were hired with only 8 terminations, leaving a total of 53 part-time employees on the St. Louis force at the close of the quarter. The above part-time figures include personnel for the administrative, meteorological, tracer, laboratory, and instrument divisions.

Table II-1 shows both full-time and part-time man-hours expended for the current period, broken down by months and activities.

TABLE II-1

FIELD OFFICE MANHOURS

		January	February	March	Total for Period
Administration	Full-time	565	643	807	2015
	Part-time	0	52	0	52
Meteorological	Full-time	993	868	997	2858
	Part-time	1148	3280	4256	8684
Tracer Test	Full-time	674	616	764	2054
	Part-time	1176	3169	2512	6857
Laboratory	Full-time	64	410	365	839
	Part-time	0	510	969	1479
Instrumentation	Full-time	176	160	183	519
	Part-time	0	249	290	539
Totals	Full-time	2472	2697	3116	8285
	Part-time	2324	7260	8027	17611
					25896

The Division Chiefs requisition part-time employees by the number and type required. The Office Manager conducts the initial interviews and effects the hiring of the part-time employees.

2. Training

Training of part-time personnel is undertaken by each Division. In general, the Division Chief, with the assistance of the Field Foreman, explains the functions and operations of the equipment, the detailed requirements for handling equipment in the field, precautions to be observed, manner of completing field data records, and manner of submitting time and mileage records. In the current period at St. Louis only meteorological tests were involved, and employees engaged in this work were instructed by the Field Foreman.

3. Facilities

The rental space at St. Louis and Minneapolis, as described in JQR 2, proved adequate during the current period. However, because of the increased space required at Minneapolis for layout of sampling equipment and assembly of personnel prior to tests, it was found necessary to install all meteorological instruments on automobiles while outside the building instead of in the garage area as had been previously planned.

4. Security

No special security measures have been instituted in connection with the St. Louis operation inasmuch as all computing and data analysis for St. Louis tests are performed in Minneapolis.

The arrangement of restricted areas and the security precautions taken at Minneapolis, as described in JQR 2 have proven satisfactory during the current period, and have been adequate even for the relatively large number of part-time employees requiring access to the unrestricted portions of the building. Uncleared personnel enter restricted areas only for approved purposes and then only under the supervision of cleared personnel. Drafting of meteorological data, computing of meteorological data, laboratory analysis of filters, and other phases of the project work performed by uncleared personnel are performed in separate areas in order to isolate these functions. Thus idle exchange of information relative to the various phases of the project is prevented as far as is practicable. Restricted areas are kept locked at all times and visitors requiring admittance to restricted areas are required to sign a log.

A fireproof safe with combination lock is located within the restricted area for storage of rough field data of a classified nature and other important records.

Fire protection facilities have been installed and include pump type water cans in the office area where records are located, and CO_2 fire extinguishers in the shop area for protection of equipment and instruments.

C. METEOROLOGICAL TESTS

1. General

The purpose of the mesometeorological tests conducted during the current period was to determine the horizontal and vertical temperature patterns to serve as a basis for the selection of tracer test sites in St. Louis and to obtain data required for determining the effect of these patterns on the diffusion of an aerosol cloud in Minneapolis.

In order to provide the necessary information for accomplishing the above purposes, traverse routes in both cities for two-meter air temperature surveys were designed to include the urban area, most of the residential area, and sufficient rural area to enable the establishment of characteristic patterns of any area which might possibly affect aerosol diffusion. Normally, five cars and occasionally as many as ten cars, when equipment was available, were used for the temperature traverses in Minneapolis. Normally, four circuits were made on each route. On those nights coinciding with tracer tests in Minneapolis, 5 to 12 traverses were completed. Wiresonde ascents in either one or two locations, usually one urban and one rural, were made each hour during the period of the traverse operation.

Operations for the period represent a total of 4,681 hours for traverses, 964 hours for wiresondes, and 2,913 hours for data reduction.

2. Test Data

Table II-2 lists all mesometeorological surveys conducted in Minneapolis in the current period and gives pertinent statistics on the number of routes, runs, wiresonde ascents, maps obtained and man-hours expended for the various phases of the operation. Table II-3 provides like information for St. Louis surveys.

3. Public Relations

The advance meetings with city officials of Minneapolis are discussed elsewhere in this Section. Meetings with city officials of St. Louis are scheduled for the purpose of completing arrangements for forthcoming mesometeorological surveys involving wiresonde operations. In both St. Louis and Minneapolis little interest has been evidenced in the operation of the traverse cars, and in Minneapolis, the removal of the two wiresonde sites from normal public traffic patterns has served to reduce public curiosity in these operations.

4. Traverse Route Planning

The purpose of the traverse routes is to provide a grid of air-temperature readings taken at the two-meter level which are adequate for establishing characteristic temperature patterns over the required area with a minimum of equipment. It is necessary that the routes cover such areas of interest as urban heat islands, rural heat lows, the tracer test area in use, and any surrounding areas that may possibly affect the diffusion of an aerosol cloud.

The length of each traverse route will vary between 12 and 20 miles, depending on traffic conditions characteristic of the city, street patterns, and street conditions. In current operations in Minneapolis, routes were

GENERAL				2 METER TEMPERATURE SURVEYS							WIRESONDE SURVEYS								
Survey No.	Date 1953	Map Times CST	Tracer Test No.	No. Routes Used	No. Runs Per Route	No. Traverse Men	No. Cars	Traverse Car Miles	Total Traverse MHrs.(P)	Traverse MHrs. per Run (P)	No. Urban Sites	No. Rural Sites	No. Special Sites	Total No. Ascents	No. Wiresonde Operators	Total Wiresonde MHrs.	MHrs. Per Ascent	No. 2 Meter Survey Maps	Tra[illegible] Red[illegible] MHr[illegible]
M34	16 Jan.	2000-2200	T 0002	5	4	15	5	245	72	3.6	1	0	0	1	6	25	25	3	
M35	19 Jan.	2000-2200	T 0003	5	4	15	5	264	88	4.4	0	0	1	3	3	30	10	3	
M36	21 Jan.	"	T 0004	5	4	15	5	297	72	3.6	0	0	1	3	3	16	5.3	3	
M37	22 Jan.	"		5	4	15	5	279	72	3.6	1	0	0	3	3	16	5.3	3	
M38	26 Jan.	"	T 0005	5	4	15		245	78	3.9	0	0	1	3	3	32	10.7	3	
M39	27 Jan.	"		4	4	12	4	247	58	3.6	1	0	0	3	3	16	5.3	3	
M40	28 Jan.	"	T 0006	5	4	15	5	243	68	3.4	0	0	1	3	3	21	7.0	3	
[illegible]	30 Jan.	"	T 0007	5	4	15	5	288	83	[illegible]	0	0	1	3	3	21	7.0	3	
M42	2 Feb.	"		5	4	15	5	310	78	.9	1	0	0	3	3	31	10.3	3	
M43	3 Feb.	2000-2300	T 0008	5	5	15	5	324	102	4.0	0	0		4	3	35	8.8	4	
M44	4 Feb.	2000-2200		5	4	15	5	[illegible]	83	4.1	1	0	0	3	3	16	[illegible]	3	
M45	5 Feb.	"		10	4	30	10	[illegible]	172	4.3	[illegible]	[illegible]	0	0	0	0	-	3	
M46	9 Feb.	1900-2400	T 0009	5	[illegible]	15	5	[illegible]	[illegible]	4.0	0	0	1		[illegible]	33	6.6	5	
M47	11/12 Feb.	2200-0500	T 0010	5	[illegible]	30	10	744	176	3.5	0	[illegible]	[illegible]	8		51	6.4	9	
[illegible]	[illegible]/14 Feb.	2000-0600		2	[illegible]	12	4	371	88	3.7		1	0	10	12	61	6.1	11	
M49	15 Feb.	1200-1900	T 0011	5	7	25	5	563	120	3.4	[illegible]	0	1	5	3	31	6.2	6	
M50	16 Feb.	1800-0100	T 0012	7	7	35	7	735	144	[illegible]	[illegible]	[illegible]	0	4	3	[illegible]	7.5	6	
M51	18 Feb.	1900-0100	T 0013	7	7	35	7	727	208		1	1	0	9	6		6.8	6	
M52	23 Feb.	1900-2400	T 0018	5	7	25	5	540	120	3.4	1	1	0	11	6	58	5.3	6	
M53	24 Feb.	1900-2300	T 0015	5	7	25	5	[illegible]	110	3.1	1	1	0	9	6	51	5.7	6	
M54	27 Feb.	1900-2400	T 0016	5	7	25	5	503	112	3.2	1	1	0	11	6	88	.0	6	
M55	3 Mar.	"	T 0014	5	[illegible]	25	5	531	128	3.7	1	1	0	9	6	56	6.2	6	
M56	4 Mar.	"	T 0019	5	7	25	5	514	124	3.5	1	0	1	7	6	56	8.0	6	
M57	6/7 Mar.	1900-0600	T 0017	5	13	30	5	920	212	3.3	1	1	0	24	12	84	3.5	12	
M58	18 Mar.	1900-2400	T 0020	5	7	25	5	509	171	4.9	0	0	0	0	0	0	-	6	
M59	20/21 Mar.	2100-0600	T 0021	5	11	30	5	566	192	3.5	0	0	0	0	0	0	-	10	
M60	24 Mar.	1900-0000	T 0022	5	7	25	5	620	180	5.1	0	1	0	3	6	45	.0	6	

TABLE II-2

MESOMETEOROLOGICAL SURVEYS
MINNEAPOLIS

…TURE SURVEYS				WIRESONDE SURVEYS							COMPUTING AND ANALYSIS					
…o. …rs	Traverse Car Miles	Total Traverse MHrs.(P)	Traverse MHrs. per Run (P)	No. Urban Sites	No. Rural Sites	No. Special Sites	Total No. Ascents	No. Wiresonde Operators	Total Wiresonde MHrs.	MHrs. Per Ascent	No. 2 Meter Survey Maps	Traverse Data Reduction MHrs. (P)	Total Map Plotting & Drafting MHrs.(P)	2 Meter Survey Analysis MHrs. (F)	No. Wiresonde Charts	Wiresonde Data Reduction & Drafting MHrs.(P)
5	245	72	3.6	1	0	0	1	6	25	25	3	30	10*	*	1	3
5	264	88	4.4	0	0	1	3	3	30	10	3	30	28	14	1	8
5	297	72	3.6	0	0	1	3	3	16	5.3	3	33	26	15	1	8
5	279	72	3.6	1	0	0	3	3	16	5.3	3	37	12*	*	1	8
5	245	78	3.9	0	0	1	3	3	32	10.7	3	27	26	18	1	10
[illegible]	247	58	3.6	1	0	0	3	3	16	5.3	3	27	7*	*	1	9
5	243	68	3.4	0	0	1	3	3	21	7.0	3	35	28	16	1	9
5	288	83	4.2	0	0	1	3	3	21	7.0	3	35	10*	*	1	10
5	310	78	3.9	1	0	0	3	3	31	10.3	3	33	10*	*	1	9
5	324	102	4.0	0	0	1	4	3	35	8.8	4	38	10*	*	1	7
5	308	83	4.1	1	0	0	3	3	16	5.3	3	33	10*	*	1	8
[illegible]	637	172	4.3	0	0	0	0	0	0	-	3	68	24*	*	0	0
5	440	119	4.0	0	0	1	5	3	33	6.6	5	45	12*	*	1	8
[illegible]	744	176	3.5	0	0	1	8	6	51	6.4	9	68	15*	*	1	16
[illegible]	371	88	3.7	1	1	0	10	12	61	6.1	11	35	3*	*	5	16
5	563	120	3.4	0	0	1	5	3	31	6.2	6	65	28	30	1	11
7	735	144	3.0	0	1	0	4	3	30	7.5	6	65	33	30	1	7
7	727	208	4.2	1	1	0	9	6	61	6.8	6	65	33	18	6	26
5	540	120	3.4	1	1	0	11	6	58	5.3	6	10	35	27	7	22
5	425	110	3.1	1	1	0	9	6	51	5.7	6	45	7*	*	7	23
5	503	112	3.2	1	1	0	11	6	88	8.0	6	50	12*	*	7	20
5	531	128	3.7	1	1	0	9	6	56	6.2	6	55	10*	*	6	20
5	514	124	3.5	1	0	1	7	6	56	8.0	6	55	8*	*	5	15
5	920	212	3.3	1	1	0	24	12	84	3.5	12	50	8*	*	18	33
5	509	171	4.9	0	0	0	0	0	0	-	6	55	28	30	0	0
5	566	192	3.5	0	0	0	0	0	0	-	10	40	48	35	0	0
5	620	180	5.1	0	1	0	3	6	45	15.0	6	30	27	24	1	12

* Work not completed as of 31 March 1953

2

TABLE II-3

MESOMETEOROLOGICAL SURVEYS
ST. LOUIS

GENERAL			2 METER TEMPERATURE SURVEYS							COMPUTING AND ANALYSIS			
Survey No.	Date 1953	Map Times CST	No. Routes Used	No. Runs Per Route	No. Traverse Men	No. Cars	Traverse Car Miles	Total Traverse MHrs. (P)	Traverse MHrs. Per Run (P)	No. 2 Meter Survey Maps	Traverse Data Reduction MHrs. (P)	Total Map Plotting & Drafting MHrs. (P)	2 Meter Survey Analyses MHrs. (F)
M1018	5 Jan.	2000-2200	3	4	9	3	208	50	4.2	3	24	7*	*
M1019	6 Jan.	"	3	4	9	3	210	50	4.2	3	26	24	12
M1020	8 Jan.	"	4	4	12	4	280	86	5.4	3	29	24	15
M1021	12 Jan.	"	5	4	15	5	297	101	5.0	3	30	22	12
M1022	13 Jan.	"	4	4	12	4	288	72	4.5	3	33	23	15
M1023	4 Mar.	"	4	4	12	4	284	62	3.9	3	25	*	*
M1024	5 Mar.	"	5	4	15	5	344	84	4.2	3	25	22	12
M1025	6 Mar.	"	5	4	15	5	402	77	3.9	3	23	9*	*
M1026	11 Mar.	"	5	4	15	5	334	72	3.6	3	23	7*	*
M1027	12 Mar.	"	5	4	15	5	380	81	4.1	3	26	*	*
M1028	13 Mar.	"	5	4	15	5	373	72	3.6	3	23	*	*
M1029	16 Mar.	"	5	4	15	5	397	109	5.5	3	28	*	*
M1030	18 Mar.	"	5	4	15	5	393	87	4.4	3	25	*	*
M1031	19 Mar.	"	5	4	15	5	390	82	4.1	3	22	*	*
M1032	24 Mar.	"	5	4	15	5	373	83	4.2	3	28	*	*
M1033	25 Mar.	"	5	4	15	5	392	109	5.5	3	27	*	*
M1034	26 Mar.	"	5	4	15	5	390	85	4.3	3	24	*	*
M1035	27 Mar.	"	5	4	15	5	373	89	4.5	3	26	*	*

(P) Part-time personnel
(F) Full-time personnel
* Work not completed as of 31 March 1953.

reduced to 8 to 12 miles because of the icy street condition prevailing during this winter period. Each route is designed to take approximately 55 minutes in route coverage time, observing maximum speed regulations of 30 miles per hour or less. Time is allowed on certain routes for the procurement of supplementary data, such as wind direction and velocity, and lake water temperatures. Normally, three men comprise the crew of a traverse car (Fig. II-1).

Design of the traverse routes has required careful consideration of traffic patterns, shopping nights, sporting events, left-turn restrictions and the necessity for avoiding dangerous intersections not controlled by signal lights. Because of inaccuracies found prevalent in the available street maps of both Minneapolis and St. Louis, it has been found necessary to conduct a trial run on each route prior to its use in a test.

5. Traverse Scheduling

Traverses are normally scheduled during the evening to cover a period of four hours at the rate of one each hour. When tracer tests are in progress, traverses are so scheduled as to provide maps beginning one hour prior to the tracer tests and ending one hour after completion of the tests. Tracer tests are also conducted from time to time during the early morning hours and during daytime in order to determine the effect of these times on the aerosol diffusion pattern. Testing times are limited to some extent by the availability of the part-time personnel used in the operations.

6. Selection of Wiresonde Sites

In order to obtain the vertical temperature structure over the heat island and the heat low, wiresonde sites are selected as close as possible to the center of the urban area and to the normally coldest surface point. It is further required that the sites selected be relatively free of surface obstacles and be accessible to vehicles. It is important in establishing any wiresonde site that the location be sufficiently removed from trees, tall buildings, and in particular, high tension power lines, to constitute a minimum hazard to operating personnel and to preclude loss of equipment at times when balloons are blown to low elevation angles. In Minneapolis the urban site is on top of a one-story building adjacent to the field office and just outside the area of tall buildings. The rural site is located in Wirth Park near Wirth Lake, a location which has proved to be a consistent low point in the temperature pattern. In St. Louis it is considered that a location on one of the many two-story buildings in the vicinity of 9th Street and Del Mar (on the periphery of the tall building area) will be near the heat island. The only feasible rural site adequate for the purpose in St. Louis is along the banks of the stream in Forest Park. It is anticipated that permission will be extended by city officials for the use of such a site.

7. Wiresonde Scheduling

Wiresonde ascents are so scheduled that the peak of the first run is reached simultaneously with the start of the second auto traverse. Ascents are then scheduled for each hour with the last peak being reached at the start of the last auto traverse. This procedure provides a wiresonde ascent coinciding with each horizontal temperature survey map. An experienced crew will normally complete one ascent to the maximum altitude of 1000 feet in a total period of 50 minutes.

8. Mobile Meteorological Stations

Mobile meteorological stations are set up for each tracer test to determine meteorological conditions existing in the area during diffusion of the aerosol cloud. Their function and type of data recorded are discussed under Meteorology in Section V-C-4.

9. Data Reduction and Analysis

Data reduction is normally accomplished by part-time personnel within four or five days after each test. The instrument readings are converted to actual temperatures by means of tables obtained from calibration curves made for each thermistor-bridge set. Interpolation to a common map time is accomplished in accordance with the procedure detailed in Stanford Quarterly Report 1856-3 Appendix A. These data are next plotted on area maps to provide temperatures along traverse routes at the points at which readings were originally taken. Wiresonde temperatures are plotted on standard graph paper. Analysis of the surface charts, consisting of determination of isothermal contours, is accomplished by the Chief Meteorologist. Analysis of individual maps takes between one-half hour and five hours depending on the degree of complexity of the thermal patterns. A summary of meteorological conditions prevailing during the test period is then prepared from examination of the analyzed horizontal temperature maps, the wiresonde curves, the raob from the nearest Weather Bureau raob station, the applicable hourly weather observations, and the surface and 700 mb charts.

10. Personnel

An adequate number of part-time personnel has been available in Minneapolis. It has, however, been difficult to obtain a sufficient number of responsible men to act as balloon crew captains for wiresonde operations (Fig. II-2). For this purpose young engineers in the first years of their career have proven the most reliable. In St. Louis it has been difficult to obtain sufficient personnel of any description and in particular responsible people for the balloon captain positions. Considering the tight labor market, this situation will undoubtedly continue throughout the period of the project in that city.

D. TRACER TESTS (MINNEAPOLIS)

1. General

During the current period, tests to determine the behavior of aerosol clouds in cities were conducted in Minneapolis only. Four areas were used for the tests as described in JQR 2. The areas consisted of a residential section (Able Area), an area traversed by a river course (Baker Area), an open and relatively flat area (Charlie Area), and a downtown section (Dog Area). The last tests in the winter series were city wide in scope. Plans for conducting similar tests in other cities will be found in a subsequent portion of this Section.

A total of 65 separate field tests were conducted in which fluorescent material was released in 61. The other four tests were performed in the process of training operating personnel, checking equipment operation in the field, and obtaining background particulate samples in the Minneapolis area. Fluorescent tracer material was released in 24 tests in the residential area, in 14 tests in the river area, in 12 tests in the open area, and in 9 tests in the downtown area. Two releases were made on a city-wide basis.

Operations for the period represent a total of 81 field experiment hours and 11,170 man-hours, including full-time and part-time personnel in the field and laboratory. Experiments were conducted predominantly in the evening hours between 2000 and 2400, with several supporting experiments being conducted in the early morning hours between midnight and 0600 and in the afternoon hours between 1300 and 1700.

SECRET

SECURITY INFORMATION

TABLE II-4

SUMMARY OF DATA ON MINNEAPOLIS TRACER TESTS

GENERAL				TEST PREPARATION					
Field Test No.	Date 1953	Type Area	Period Hrs. CST	Test Planning MHrs. (F) (a)	Filter Prep. MHrs.(P)	Flow Rate MHrs.(P)	Equip. Prep. MHrs.(P)	Total Prep. MHrs. (F & P)	Prep. MHrs. per Sampler (F & P)
0001a	15 Jan. (Initial Equipment Check Test)			-	-	-	-	-	-
0002a 0002b	16 Jan. "	Resid. "	2000-2100 2130-2230	30	4	20	17	71	2.5
0003a 0003b	19 Jan. "	Resid. "	2000-2100 2130-2300	18	9	23	17	67	1.7
0004a 0004b 0004c	21 Jan. " "	Resid. " "	2000-2100 2120-2220 2240-2340	20	9	33	33	95	1.8
0005a 0005b	26 Jan. "	River "	2000-2100 2130-2230	36	7	38	33	114	2.0
0006a 0006b	28 Jan. "	River "	2000-2100 2130-2230	24	10	41	36	111	1.3
0007a 0007b 0007c	30 Jan. " "	River " "	2000-2100 2130-2230 2300-2400	20	15	30	36	101	1.3
0008a 0008b 0008c	3 Feb. " "	Resid. " "	2000-2115 2130-2245 2300-0015	30	30	21	26	107	1.2
0009a 0009b 0009c	9 Feb. " "	Resid. " "	2000-2115 2130-2245 2300-0015	25	27	17	24	93	1.0
0010a 0010b 0010c 0010d	12 Feb. " " "	Resid. " " "	0015-0115 0135-0235 0300-0400 0415-0520	12	25	17	20	74	.76
0011a 0011b 0011c	15 Feb. " "	Resid. " "	1400-1525 1530-1655 1700-1800	12	17	20	28	77	.81
0012a 0012b 0012c 0012d	16 Feb. " " 17 Feb.	Open " " "	2200-2240 2240-2320 2320-2400 2400-0040	48	15	25	30	118	1.2
0013a 0013b 0013c 0013d	18 Feb. " " "	Open " " "	2100-2200 2200-2245 2245-2320 2320-2400	36	13	23	34	106	1.05
0014a 0014b 0014c	3 Mar. " "	Resid. " "	2000-2120 2120-2240 2240-2340	12	10	16	19	57	.57
0015a 0015b 0015c	24 Feb. " "	City " "	2000-2115 2115-2230 2230-2330	24	10	17	20	71	.65
0016a 0016b 0016c	27 Feb. " "	City " "	2000-2115 2115-2230 2230-2345	16	10	14	18	58	.53
0017a 0017b 0017c	7 Mar. " "	City " "	0030-0145 0200-0315 0330-0445	16	[illegible]	23	27	76	.68
0018a 0018b 0018c 0018d	23 Feb. " " "	Open " " "	2000-2100 2100-2200 2200-2300 2300-2400	12	10	19	23	64	.63
0019a 0019b 0019c	4 Mar. " "	River " "	2000-2120 2120-2300 2300-2400	12	10	14	28	64	.63
0020a 0020b 0020c	18 Mar. " "	Resid. " "	2000-2100 2120-2220 2240-2340	10	10	14	30	64	.61
0021a 0021b 0021c 0021d	21 Mar. " " "	River " " "	0030-0130 0200-0300 0330-0430 0500-0600	12	10	17	28	67	.64
0022a 0022b	24 Mar. "	All City "	1930-2300 2300-0230	10	8	12	33	63	.62

	AEROSOL GENERATION					
Field Test No.	Time Hrs. CST	Type Source	Elev.	No. Operators (P)	Total Operator MHrs. (P)	Vehicle Miles
0001a	-	-	-	-	-	-
0002a 0002b	None	-	-	-	-	-
0003a 0003b	2032 2135	Pt. "	Veh. "	2	12	18
0004a 0004b 0004c	2010 2123 2243	Pt. " "	Veh. " "	2	12	15
0005a 0005b	2022 2138	Pt. "	Veh. "	2	10	18
0006a 0006b	2015 2148	Pt. "	Veh. "	2	10	18
0007a 0007b 0007c		Pt. " "	Veh. " "	2	15	21
0008a 0008b 0008c	2006 2134 2304	Pt. " "	Veh. " "	2	15	15
0009a 0009b 0009c	2017 2135 2305	Pt. " "	Veh. Roof Veh.	2	15	16
0010a 0010b 0010c 0010d	0020 0140 0305 0425	Pt. " " "	Roof Veh. " "	2	12	16
0011a 0011b 0011c	1405 1535 1710	Pt. " "	Roof " Veh.	2	10	14
0012a 0012b 0012c 0012d	2200 2254 2345 0050	Pt. " " "	Surf. " " "	2	12	12
0013a 0013b 0013c 0013d	2030 2135 2230 2355	Pt. " " "	Surf. " " "	2	10	10
0014a 0014b 0014c	2005 2125 2245	Pt. Line "	Veh. " "	3	15	18
0015a 0015b 0015c	2006 2155 2235	Pt. " "	Veh. " "	2	10	10
0016a 0016b 0016c	2027 2125 2235	Pt. " "	Veh. " "	2	10	11
0017a 0017b 0017c	0051 0211 0340	Pt. " "	Veh. " "	3	15	11
0018a 0018b 0018c 0018d	2015 2110 2212 2308	Pt. " " "	Surf. " " "	2	10	32
0019a 0019b 0019c	2005 2125 2305	Line " "	Veh. " "	3	15	21
0020a 0020b 0020c	2005 2125 2245	Line Pt. Line	Veh. " "	3	17	28
0021a 0021b 0021c 0021d	0045 0215 0350 0515	Pt. " " "	Veh. " " "	2	14	19
0022a 0022b	2000 2300	Line "	Veh. "	3	21	51

	SAMPLING								
Field Test No.	Samplers Used	Exposed Outdoors El.1-6 ft.	Exposed Outdoors El.>6 ft.	Exposed Indoors	No. Operators (P)	Total Operator MHrs. (P)	Operator MHrs. per Sampler per Release (P)	No. Sampler Cars	Total Sampler Car Miles
0001a	-	-	-	-	-	-	-	-	-
0002a-b	28	28	0	0	16	54	.96	12	170
0003a-b	40	40	0	0	18	96	1.20	11	161
0004a-c	52	47	2	3	23	132	.85	17	248
0005a-b	56	53	3	0	29	160	1.43	20	344
0006a-b	83	77	5	1	42	240	1.45	33	584
0007a-c	75	70	4	1	33	200	.89	27	694
0008a-c	92	68	4	20	49	291	1.06	40	701
0009a-c	93	72	4	17	47	324	1.16	36	624
0010a-d	97	87	3	7	39	305	.79	36	667
0011a-c	96	82	5	9	40	269	.95	38	644
0012a-d	101	101	0	0	32	281	.70	30	1182
0013a-d	101	101	0	0	45	321	.79	41	1426
0014a-c	100	90	4	6	37	258	.86	35	653
0015a-c	110	54	24	32	40	274	.83	33	511
0016a-c	110	50	25	35	40	292	.89	33	528
0017a-c	110	60	25	25	39	268	.80	36	636
0018a-d	101	101	0	0	44	320	.79	38	1357
0019a-c	100	95	2	3	48	333	1.11	33	748
0020a-c	104	103	1	0	31	236	.76	26	633
0021a-d	104	104	0	0	31	280	.68	27	721
0022a-b	102	88	14	0	42	374	1.90	32	1506

	ANALYSIS								METEOROLOGICAL			
Field Test No.	No. Slides	Slide Prep. MHrs. (P)	Prelim. Eval. MHrs.(F)	Slide Counting MHrs.(P)(b)	Counting MHrs. per Slide (P)	Total Computing MHrs.(F)	Drafting MHrs. (P & F)	Plotting MHrs. (F)	Met. Survey No.	Met. Station Street Level	Met. Station Roof-Top	Field Test No.
0001a	-	-	-	-	-	-	-	-	None	-	-	0001a
0002a-b	55	10	-	N.C.	-	-	8	-	M-34	2	0	0002a 0002b
0003a-b	120	17	8	90	.75	10	24	6	M-35	2	1	0003a 0003b
0004a-c	146	17	8	95	.65	12	24	8	M-36	2	1	0004a 0004b 0004c
0005a-b	116	12	7	65	.56	10	30	6	M-38	3	0	0005a 0005b
0006a-b	166	18	8	90	.54	17	27	8	M-40	3	0	0006a 0006b
0007a-c	248	25	10	101	.41	20	22	10	M-41	3	0	0007a 0007b 0007c
0008a-c	165	[illegible]	12	182	.70	27	16	14	M-43	2	1	0008a 0008b 0008c
0009a-c	387	48	10	170	.44	30	20	15	M-46	2	1	0009a 0009b 0009c
0010a-d	407	15	11	158	.38	31	27	16	M-47	2	1	0010a 0010b 0010c 0010d
0011a-c	339	13	8	121	.35	27	25	13	M-49	2	1	0011a 0011b 0011c
0012a-d	399	28	8	170	.38	30	46	10	M-50	2	0	0012a 0012b 0012c 0012d
0013a-d	404	23	9	173	.43	28	40	10	M-51	3	0	0013a 0013b 0013c 0013d
0014a-c	367	24	7	115	.31	25	27	13	M-55	3	1	0014a 0014b 0014c
0015a-c	412	20	8	135	.33	30	28	16	M-53	3	1	0015a 0015b 0015c
0016a-c	420	19	8	126	.30	30	28	16	M-54	3	2	0016a 0016b 0016c
0017a-c	422	21	8	127	.30	28	25	10	M-57	3	2	0017a 0017b 0017c
0018a-d	404	21	8	204	.50	25	40	12	M-52	4	0	0018a 0018b 0018c 0018d
0019a-c	319	16	7	105	.33	24	20	8	M-56	4	0	0019a 0019b 0019c
0020a-c	312	16	7	117	.38	20	32	8	M-58	2	1	0020a 0020b 0020c
0021a-d	403	16	8	133	.33	20	29	11	M-59	3	0	0021a 0021b 0021c 0021d
0022a-b	219	12	6	75	.34	13	16	6	M-60	3	2	0022a 0022b

Footnotes: (F) Full-time hours; (P) Part-time hours; (a) Includes mapping time; (b) Includes training hours field meteorological stations, and to sampler operators using parked automobiles for sampler stations. The cards are prominently displayed on windshields while the automobiles are in such use.

In connection with the phase of the program concerned with the penetration of aerosols into residences and buildings, city officials were advised of a subsidiary requirement for determining the degree of infiltration of smoke screens into a few representative residences. At the request of field representatives, complete rosters of personnel in both the police and fire departments were furnished. It was anticipated that employees in these departments could be contacted in each of the test areas regarding location of equipment in homes. A letter of introduction to Minneapolis city employees and to citizens in general was prepared by the Mayor requesting the cooperation of persons contacted in connection with the test program. This letter was later augmented by similar documents from the Minneapolis Air Pollution Control Engineer and the Chief of Civil Defense. This portfolio was delivered to the field office and was of great help to personnel in the process of securing use of private homes, buildings, and land for equipment locations. Thus "official sanction" was given to otherwise questionable requests. Even so, field personnel encountered a considerable number of refusals to cooperate with requests for permission to locate sampling equipment in homes. As many as ten contacts were made for each acceptance. Only two city employees were found to resid in the test areas selected, and it was necessary, therefore, to resort to house-to-house canvassing to obtain the necessary residences. The Northwestern Bell Telephone Company, the Northwestern National Bank, and other large and small building owners in the city proper have cooperated fully in permitting sampling equipment to be located throughout these structures. Likewise, little difficulty was experienced in obtaining use of farm land for the open-area tests. For this operation some half dozen owners granted permission to the field office to survey a grid system, and to erect stakes for some 100 sampler locations. Permission was granted for full run of the land by operating personnel in the tests involving use of this area.

During the first several field tests in the residential area, the police received numerous calls from residents reporting strange activities in the area. The sampling phase in particular aroused considerable curiosity. For several evenings in succession, sampling equipment was molested by curious passers-by, and several sampling units were actually found missing from stations. All of these were eventually recovered, however, either being returned by citizens in the area or by the police to whom the samplers had been turned in.

The local press has been cognizant of the proposed operations in Minneapolis, having been represented at a city council meeting early in the program in which the purported nature of the program was presented. As a result of the general interest stimulated by the appearance of equipment in the first field tests, the Minneapolis Tribune carried the following article on 20 January 1953:

> "In summer it was flying saucers. In winter it's little gray boxes that just sit on street corners, ticking and purring.

"Several Minneapolis residents phoned police Monday about 'ticking boxes' sitting in the snow in front of their homes. Most of the reports came from the vicinity of Clinton Avenue between Twenty-seventh and Lake Streets.

"'I am not at liberty to say what these boxes are,' said E. I. (Pat) Walling, inspector of uniformed police, 'but they are nothing for citizens to get alarmed about.'

"One observer indicated the boxes are being used in a series of tests intended to help the Army learn to throw smoke screens over American cities. They could be used to measure the concentration in the air of a fine, harmless powder blown over the city.

"The Minneapolis Tribune learned in November that The Ralph M. Parsons Company of Los Angeles, California, would conduct some 40 tests for the Army Chemical Corps in the Twin Cities area. This firm's name appears on cars from which guards watch the boxes.

"Government research has shown that even in an age of radar-bombing, it may be desirable to hide cities with smoke screens in event of atomic attack. It is not known if any smoke has been released over Minneapolis. Several other cities also are involved in the tests.

"The metal boxes are about 14 by 14 by 10 inches in dimension. A small metal nozzle extends from the side. The noise coming from the boxes may be from a small battery-operated suction motor.

"Worried guards at Twenty-seventh Street and Clinton Avenue conducted a fruitless search for a missing box last night. Another one of the machines disappeared at Lake Street and Clinton. A guard said they are worth 'a couple of hundred dollars.'

"The Parsons company has offices at 918 Third Avenue South and employs 10 full-time people and some 65 part-time workers. Many of these workers place and guard the boxes at city intersections. Guards park their cars so they can watch two boxes at one time on a corner. Nothing on or near the box indicates their purpose.

"'They need changing every three hours,' one guard remarked, but he would not allow a Tribune reporter to look beneath the lid."

Other local newspapers followed with reports of similar content. Public curiosity diminished rapidly following these press releases. However, to prevent further idle tampering or actual loss of equipment by theft, operators were furnished chains and locks with which the sampling equipment could be secured to trees, lamp poles, or similar permanent objects. Few molestations of consequence occurred during the balance of the program.

4. Test Planning

Both general and specific requirements for the Minneapolis winter tests were outlined for the field office by Stanford University. Such plans have specified:

a. The point or line source type of aerosol generation, elevation requirements, and general order of the quantity of tracer material to be released for each type of generation,

b. The approximate number of tests to be conducted in each area and the operating hours such as early evening, early morning, and afternoon,

c. The general extent of the sampler array for certain special tests,

d. Special requirements, such as location of sampling equipment in residences and buildings.

The first four tracer tests were planned and supervised jointly by Stanford and Parsons personnel. Subsequent planning and operational supervision were performed by the Parsons field office.

The actual planning of the test is undertaken with specific objectives in mind such as area to be used, meteorological conditions required, period of operation, types and relative locations of aerosol generation, and special locations of sampling equipment. The initial test arrays involved a limited number of samplers consistent with the small group of inexperienced part-time workers then available. These test arrays were essentially rectangular in shape. As the operating force increased in proficiency and number, it became possible to place a greater number of units in the field, and consequently the areal extent of the arrays was increased to meet more nearly the specific objectives of the winter test program.

It was found expedient, however, in planning larger tests later in the program, to continue to define a generally rectangular grid of samplers in the center of the test area. This basic core, then, can be planned 24 hours or more in advance, and the necessary mapping and preparation of operator instructions for this arrangement can be scheduled prior to the peak effort period just preceding the test. The permanent core normally includes any residences or buildings to be used for sampling or aerosol generating stations. Therefore, time-consuming arrangements for use of such premises may be scheduled well in advance of the test.

The field office meteorological group, in close liaison with the Weather Bureau at Wold-Chamberlain Airport, furnishes progressively more accurate forecasts of weather and wind conditions to be expected at the time of the test, beginning with a five-day advance forecast and carrying through to the conclusion of the actual test. Six hours prior to the test the meteorological group prepares a final forecast, based on the most recent weather information available at the Weather Bureau and upon data furnished by field office instruments. Design of the final test grid is undertaken at this time, with sampler locations being prepared as an adjunct to the basic grid system, consistent with test objectives and the anticipated wind direction.

The sampler array represents a compromise between two requirements. First, sufficient equipment must be provided within the area anticipated to be covered by the cloud, to determine such parameters as the axis of travel, regions of constant concentration, and behavior of the cloud on the downwind side of buildings. Second, some equipment must be located outside the anticipated region of cloud coverage to define a line of some minimum effective concentration. Since the very nature of these results is the object of the experiments, and is not specifically known, the array must be designed with sufficient "safety factor" to ensure accommodation of the aerosol cloud while it is being diffused from the source while under the influence of winds which may vary in direction and velocity. For a point-source experiment an array of samplers within an included angle of approximately 60 to 90 degrees, with the aerosol generator just inside the apex, has been found to constitute a suitable system for the initial test program.

Refinements or modifications of the initial plan of a given test may be made in the field prior to a release to accommodate any significant change in wind direction. The aerosol generator may be relocated or sampler positions may be changed to form a more adaptable grid. The extent of such maneuvers is controlled by the time available for moving the equipment, the adequacy of field communications, and the degree to which some specific test objective, such as determination of the effect of generator location on diffusion of the cloud, may be altered.

The scheduling of operating personnel for a test is given in a subsequent portion of this Section.

5. Sampling

The University of Minnesota has been the principal source of men for part-time employment as sampler operators. A small percentage of the field crew represents men employed in various private and civil occupations. Prerequisites for hire are that men meet minimum security requirements and that each man have a means of transportation. The net increase in part-time employees assigned to the Tracer Test Division for the current period is approximately 60 men.

As the test program progressed, methods of scheduling personnel, training of operating crews, disseminating test plan information, performing certain pre-test operations such as flow rating filter units to be used in the samplers, dispatching men into the field, and maintaining contact with and control over the crew while in the field were steadily improved.

The scope of initial tests was limited to permit determination of basic personnel capabilities and to establish methods for training crews with a minimum of confusion. For the first half dozen operations, all available men were scheduled to report to the field office approximately two hours prior to the time planned for the first tracer release. This small force, averaging less than 20 in number, was assembled to receive operating and special test instructions. A standard operating procedure formed the basis for discussion. After a question-and-answer period, each man was issued the necessary field data sheets, completed with respect to sampler location and exposure requirements for the evening's operations. Each operator was then assigned a number of sampling units, and the test directors demonstrated the initial filter flow rating procedure with the assistance of the field supervisors. The men and their equipment were then dispatched to field positions. Contact with men in the field and checking of sampler locations were accomplished by the test command car making a circuit of the whole test area. The crew was again used for final flow rating of filters after equipment had been returned to the field office at the end of the test period.

As the operating force became proficient, several lead men were selected to act as crew captains, and the balance of the force was divided into groups and assigned under these men. Each crew presently consists of about eight to ten men. The crew captains are delegated the responsibility for training of new men assigned to the crews, disseminating special test instructions, dispatching men to the field with proper equipment, and checking to ensure proper location and operation of sampling equipment in the field, all under the guidance of field office supervisors. The system of decentralizing supervision of a large number of men has been successful and has increased the operating efficiency of the test organization as a whole.

A time and availability chart is now prepared for the entire field force. This schedule serves as the basis for hiring additional personnel for scheduling of part-time employees for work in the field office prior to a test and for the actual field tests.

A tentative operating schedule is prepared and posted regarding the activities to be conducted for the following several weeks. This information includes dates of tests, and areas and hours of operation. Crew captains are contacted by telephone when a test has been established definitely as to date, hours of operation, and number of men required. Crew chiefs then schedule men in their crews for the operation and report in advance of test time regarding availability of manpower. The total part-time force is necessarily established at a level exceeding the maximum manpower requirement for the largest operation in order to ensure that a full working crew is available for any given test. Relatively few manpower scheduling problems were encountered during the current period, and the working force for tracer tests was stabilized in the neighborhood of 60 men, including crew chiefs. One problem inherent with employment of students, however, is the general dearth of manpower during periods of final examinations and vacations. This shortage was experienced just prior to and during the University of Minnesota's spring vacation. During this period tests were conducted with some difficulty.

Under present procedures, flow rating of filter units is performed well in advance of the time that the operating crew is scheduled to report for a test. Several part-time workers generally can be scheduled to perform this work during the day preceding the test. A discussion of the flow rating procedure is included in Section V of this report.

Samplers are arranged in the equipment assembly area of the field office in separate groups for each field crew. Loaded filter holders are arranged in perforated trays in the laboratory, and these are transported on small castered tables along lanes between samplers so arranged for flow rating (Fig. II-3). Filter holders are selected in the proper quantity for each sampler, and flow rates and holder numbers, together with the sampler identification number, are recorded on data sheets which are then stored in the sampler box. Sampling equipment is completely prepared for service and arranged for the most efficient dispatching into the field prior to arrival of the operating crew. Stand-by time of a large number of men is thereby reduced to a minimum since the field-crew time schedule permits only sufficient time in advance of the test to receive necessary instructions and equipment and to take positions in the field.

The crew captains alone are assembled prior to the arrival of the general crew at which time special instructions are given relative to the forthcoming operations. Each man is provided with a map showing the locations of men and equipment under his cognizance. These instructions are then disseminated as necessary to each crew. The crew chief dispatches men to field locations with proper equipment and performs the necessary function of checking locations and operations in the field during the experiment.

Each man in the initial tests was assigned to operate one or two sampling units. Where two units were assigned, one was located in the operator's automobile and the other not farther than one-half block distant. As operator proficiency increased, it was found that the optimum number of samplers to be operated by one man was three when located one-tenth of a mile or more apart. Based on the performance of average employees handling from two to five sampling units each, this three-unit standard was established primarily because frequent inspections of remote equipment were necessary to discourage tampering by curious people. A greater number of samplers may be tended by one man if located in an unpopulated area or in a building where relative security is assured. Where flexibility of the grid system is an important factor, it was found that as a general rule one man can relocate a maximum of three samplers from one side of a one-half mile square grid to the opposite side in the 30 minutes generally allotted between test periods. Subsequent releases are delayed where time required for transporting and setting up equipment in other locations exceeds the normally scheduled interval.

During a field test the crew chiefs not equipped with portable radio are contacted by the command car. Radio equipment is normally issued to crew supervisors cognizant of samplers which are located in areas of the sampler array most likely to be "deactivated" by a significant shift in wind direction. With radio communication facilities, the instructions for revision of sampler locations can be issued to field crews in the shortest possible time by having the crew chief contact the operators so affected.

After a field test the samplers are returned to the equipment assembly area and arranged in the groups from which they were originally taken. Those samplers which were located within a radius of 150 feet downwind of the aerosol disperser are segregated into a special group and marked for examination of the exterior of the box under ultraviolet light to determine the presence of fluorescent particles. If such examination indicates the presence of excessive amounts of the tracer material, the cases are washed with a detergent to eliminate a possible source of contamination within the premises. All final flow rating is undertaken by a small crew immediately after each test to provide for release of sampling equipment to battery charging crews. Exposed filter holders are then arranged on small trays in an ordered sequence suitable for preliminary examination on the following day (see Section V).

While field operations in the residential, river, and downtown areas were not materially hindered by deep snow, this was not the case for the open test area. High drifts and the general inaccessibility of sampler stations made operations in this area extremely difficult. Transportation of sampling equipment for long distances over the open area was facilitated by use of sleds and toboggans. During the first open-area field test, the temperature dropped to well below zero degrees Fahrenheit, and under this condition it was first perceived that small ice crystals formed on some of the filters. With a small starting nucleus, many formations grew so large as to cover half of the top of the filter. The origin of these crystals is believed to be from several sources such as from moisture in the breath of operators and from small air-borne ice and snow crystals. The effect of this phenomenon on the analysis of filters will be discussed in a subsequent JQR dealing with the field tests involved.

6. Aerosol Generation

Because of the nature of the equipment, part-time employees assigned to the aerosol generator crew were selected from those men possessing some mechanical aptitude and technical background. Operation of the dispersal equipment requires a reasonable degree of mature judgement and the ability to follow a multiple step operating sequence. Three men are presently assigned to this crew. A discussion of the operating procedure for the aerosol generator is included in Section V.

An operating manual prepared by Stanford University for the blower type aerosol generator with mechanical feeder was the basis for training men assigned to this crew. The initial training procedure included a practice run in the New Brighton, Minnesota, area in which personnel performed all operations incident to the aerosol generator phase of a field test, including placement of equipment, preparation of the bulk material for dispersal, initial and final weighing, and actual dispersal of tracer material over a representative period of time.

It was recognized at the beginning of the field project that in order to ensure validity of results obtained from tests using the fluorescent tracer technique, the control of contamination of office and laboratory facilities by tracer material was of paramount importance. In order that contamination of the premises in which the analytical work is performed be reduced to an absolute minimum, it was planned that bulk tracer material and all equipment used in connection with the aerosol generation process be stored at a location remote from the field office. A convenient arrangement was made with the chief of the disperser crew for storage of all of this equipment at his home in New Brighton, Minnesota, some eight miles distant from the field office. The panel truck used for transportation of the generator and crew during test operations is procured from a rental agency also remotely located from the field office. The pick up and return of this vehicle are arranged for entirely by members of the generator crew. Under present procedures the lead-acid aircraft batteries comprising the power pack for the generator are stored and charged at the field office because of the availability of battery charging facilities there. The power pack is segregated from other equipment upon its return from a field operation, however, and is examined under ultraviolet light and immediately decontaminated, if required, by scrubbing with a detergent and water outside the building. This power pack is to be charged and stored elsewhere during all forthcoming test periods to eliminate any possibility of contamination of field office premises from this source.

Other sources of contamination such as the generator operating personnel, portable radio equipment used by this crew, and field operation data sheets are excluded from the field office premises. The miniature lead-acid batteries for the radio are charged there, however, and the radio is stored at the remote location. Dispersal operation notes are transcribed to clean sheets in the field, and contaminated sheets are then destroyed.

For a typical field experiment, the dispersal crew on the truck reports to the field office sufficiently in advance of release time to receive special instructions and batteries. The crew is then dispatched to the test area, where radio contact is maintained at all times with the test director. At the dispersal point, after the tracer material has been released, necessary weighing and loading operations in preparation for the subsequent release are performed in the vehicle.

7. Test Direction

During an operation the Field Test Director, either the Chief of the Tracer Test Division or the Assistant Project Engineer, is assisted by the Chief of the Meteorological Division, or his assistant. Field test operations are either directed from a command car, which is provided with a 30 watt mobile transmitter and receiver, or from the field office which is provided with a 60 watt main base transmitter and receiver. The command car is used as a base of operations particularly in the remote test areas which are beyond the effective transmitting range of the small portable radio equipment.

Street level and roof top meteorological stations begin to report local wind direction and velocity, as observed from instruments and from the track of small helium-filled free-flight balloons, an hour before the time scheduled for the first tracer release. These reports are continued at 15 minute intervals, or as otherwise required, to furnish the Test Director with a complete mesometeorological picture of the test area. Where a shift or trend in wind direction significantly different from the planned direction is noted, relocation of sampling or generator equipment may be required. Such revisions in test plans are issued to field crews either prior to leaving the equipment assembly area, or are issued to crew captains in the field by the main base or command car radio.

When reports are received that final equipment positions have been taken, and that filters are exposed and samplers started, the command car proceeds to the location of the aerosol generator for the start of the test.

Final reports are received from remote field meteorological stations, and when all conditions are satisfied, the aerosol generator crew is instructed to proceed with dispersal. A low trajectory free-flight balloon is released from the disperser location during tracer dispersal to further define the local wind direction.

Several spare sampling units, complete with flow rated filters, are carried in the command car for replacement of any units found to be malfunctioning in the field.

8. Equipment Preparation

a. Sampling Equipment

As soon as samplers are returned from the field and flow rating of filter holders is accomplished, preparation of the equipment is begun for the subsequent operation. The pumps are removed from the cases and are stored on shelves adjacent to the equipment assembly area. Any pumps that did not operate properly in the field are segregated in preparation for check-up in the instrument shop.

Servicing and charging the lead-acid aircraft type batteries used in the samplers represent the major item of equipment preparation for a test operation. Three hours of operation of the sampler pump depletes the capacity of a fully charged battery, represented by an initial specific gravity of 1.295 or more, to a condition in which the battery is unreliable for further extensive service. Specific gravity readings after such a period of service average less than 1.225, indicating the need for a full recharge.

Representative cells in each battery are checked with a hydrometer and the average reading noted. Electrolyte level is checked and a carefully measured charge of distilled water is added as required. Sampler cases with batteries are then arranged on racks in the battery charging room, and connections are made to the charging circuits (Fig. II-4).

Charging facilities consist of two Lincoln Electric taper rate generators with a rated charging capacity of 700 ampere hours each (Fig. II-5). Positive and negative direct current busses are installed directly on the charging racks. Male electrical plugs are permanently wired in series between these busses, and connection of a battery for charging is accomplished by inserting a plug into the mating receptacle in the sampler case. Thus, hookup work required for connection of batteries for charging is reduced to a minimum. All batteries in a series string are arranged to be in essentially the same condition of discharge, or specific gravity level, to ensure equal charging of all. The present racks accommodate a total of 36 batteries for each charger, and it is found that all except extremely discharged batteries are adequately charged in an eight hour period.

Charging racks were constructed in six foot sections to facilitate their handling, loading, and transportation between the field offices in the several cities to be used for the project tests.

After a full complement of samplers has been charged, each battery is again checked by a hydrometer or a wide scale voltmeter. Batteries failing to come to an acceptable charge are reserved for recharge. Sampler cases are then arranged in rows in the equipment area in the order in which samplers are to be dispatched into the field. Pumps are assembled to the cases after which run-in and flow rating may proceed for the forthcoming test. It has been found that the flow rate of a new vane type vacuum pump increases for a short period as the vanes wear in and become seated. New pumps, therefore, are given a shop run-in period of approximately an hour.

b. Aerosol Generator

The batteries comprising the power pack for the aerosol generator ordinarily require charging after two series of tests, except where dispersals have been of the time consuming, line source type.

The blower is detached from the generator equipment after each dozen releases, and any fluorescent material found encrusted on the internal surfaces is dislodged with a brush or sharp object. Only an accumulation of tracer dust has been noticed in such examinations, since all rough surfaces and projections were scraped and filed before initial assembly of the generator in order to preclude entrapment of material.

The initial load of fluorescent material is added to the feed mechanism hopper at the remote storage location. Additional tracer material is placed in a capped container, to be used for makeup to the feed hopper in the field after each release.

9. Analysis

The work of the analysis group includes all activities incident to the preparation of filters for exposure in the field, the preliminary evaluation of exposed filters after a test, the mounting of exposed filters on slides, the counting by microscopic techniques of fluorescent particles, computations relative to determination of concentrations of the tracer simulant at the various sampler stations, and plotting of these values on the test area maps. This work is performed by members of full-time field office force and part-time employees as described hereinafter.

Personnel hired for part-time work in the particle counting laboratory are required to have had microscope or related laboratory experience at the college level. The major source of these workers is the University of Minnesota, from which women in the dental and nursing schools and men in the graduate technical schools have been recruited. Several of the men employed in this work are ot[illegible] employed as technicians in various State of Minnesota agricultural, dairy, and drug laboratories. The laboratory force numbers approximately 20, of which approximately 75 per cent are women.

Newly hired technicians are required to read a detailed manual outlining all pertinent operating phases of the work, after which familiarity with equipment and procedures is gained by counting standard slides. It has been found that an acceptable counting proficiency is obtained on the average after some ten counting hours, although workers normally employed at work requiring the use of a microscope become familiar with specific techniques in a shorter time.

Several part-time technicians have been trained in the work of filter holder preparation (Fig II-6) and mounting of exposed filters on slides.

Because of the great volume of filter analysis resulting from performance of a large tracer test program, and the requirement that analysis of a field test be completed as soon as possible after the test, the laboratory counting facilities must be staffed as completely as possible during working hours. Five counting stations are available, (Figs. II-7 and II-8), and it has been considered necessary to schedule use of all these facilities from the start of each week day until 2100 or later, with a full eight hour use of the facilities on Saturdays, to reduce the large backlog of counting work resulting from the concentrated Minneapolis testing program.

Personnel are scheduled in relays throughout the day, with a two hour counting period representing the average time a person can spend in concentrated analysis without experiencing eye fatigue. In many cases, however, technicians accustomed to using a microscope regularly find it possible to count for four to five hours by taking a short break every hour or oftener. Less experienced operators are given calculation or computing work to perform for an hour between counting periods. The morning hours of the day have been found to be the most difficult in which to schedule personnel for counting operations, since those hired are predominately students. Facilities are generally well staffed during the afternoon hours, and evening hours are well taken up by personnel who are employed elsewhere during the day. Operation of the laboratory facilities requires the supervision of qualified full-time technicians during all hours that the facilities are in use.

In preparation for a tracer test, several laboratory technicians are assigned to prepare filter holders. Metal holders and plastic dust caps are washed in a detergent solution to remove any traces of fluorescent material remaining from a previous test. After drying, holders are arranged on perforated trays, and membrane filters are inserted into the holders. Trays of prepared filter holders are then stored in a dust-free cabinet in the laboratory until such time as filters are required for flow rating in the equipment assembly area.

After the tracer test, exposed filter holders are arranged on small racks in an ordered manner in preparation for preliminary examination and evaluation of results. The method of preliminary evaluation is discussed in Section V. All preliminary examination work, in which field location and exposure data sheets are identified with the respective filter holders, is performed by cleared full-time laboratory technicians to preclude compromise of results. After preliminary evaluation work, holders are returned to the preparation laboratory where membrane filters are mounted on glass slides. This work is performed by part-time technicians. In this process, glass slides are thoroughly cleaned in a detergent solution and then dried. A coded slide number, assigned by cleared full-time technicians, is given to each slide by means of a gummed label. Exposed filters are carefully applied to the slides with a thin rubber cement. Mounted slides are stored in slide boxes in an ordered manner and are sent to the counting room. The full-time technician in charge of the laboratory operations supervises all of the filter and slide preparation work. All instrument setups as well as any repairs or adjustments of the equipment are made by the full-time laboratory supervisor.

With results of the preliminary evaluation of test-exposed filters, the Test Director prepares a plot of tracer material concentrations at the sampler locations for each release. In this manner, preliminary results of a test can be determined within 24 hours after the operation. These preliminary plots form the basis for design of subsequent tests by providing an indication both of the adequacy of the previous sampler array and the effectiveness of maneuvers taken to encompass the aerosol cloud.

From final fluorescent particle count data the total particle population of a filter is calculated, and based on the known average flow rate through the filter, the total dosage of tracer simulant is calculated in particle minutes per liter. All computations of this nature are performed by cleared full-time personnel in the restricted area of the field office. The final total dosage data, in addition to virtual wind track vectors, balloon track directions, and aerosol release information, are then plotted on maps of the test area in preparation for more detailed analysis of the test results. A discussion of results of certain tracer tests conducted during the current period will be found in Section V.

E. SCHEDULED OPERATIONS

At the beginning of the project, tentative plans were made to conduct tracer tests in Minneapolis and St. Louis during the winter of 1953, the summer of 1953, and the winter of 1954. In addition, it was planned to conduct tracer tests in various industrial complexes in and near St. Louis during the fall of 1953. Prior to conducting tracer tests, mesometeorological surveys were to be made for several months duration in order to determine the general thermal structure prevailing in these areas to serve as a basis for choice of tracer test areas. It was also recognized that meteorological surveys and tracer tests in Winnipeg during the summer of 1953 would be of scientific interest and would provide useful information by virtue of the long days and short nights prevailing there during the summer. The tentative 1952-1953 winter test schedule represented an optimum program which would be difficult to meet because of problems involved in designing and fabricating instrumentation in sufficient time for a full program.

The actual program of tests conducted to date includes meteorological surveys in Minneapolis and St. Louis to establish meteorological patterns. In addition to the meteorological surveys, tracer tests were conducted in Minneapolis for a period of approximately ten weeks. Because of the late start of tests in Minneapolis, it was considered desirable to obtain as much complete data on that city as possible rather than attempt to divide a short test period between Minneapolis and St. Louis.

Tentative plans have been made for future testing, based on experience to date and a desire to obtain as much useful information as feasible during the remainder of the program. Current planning is based on the assumption that it will be possible to operate in Winnipeg during the summer of 1953. From experience gained thus far in conducting field office operations, it is indicated that a minimum period of ten days would be required between completion of tracer tests in St. Louis and commencement of tests in Winnipeg. The performance of tracer tests in St. Louis or Winnipeg involves equipment transportation, procurement of temporary quarters, training test crews, and making arrangements to initiate tests. On the other hand, it appears that such a move could be made to Minneapolis from either Winnipeg or St. Louis in approximately seven days, since the facilities for tracer tests there are well established.

Table II-5 shows the proposed tracer test schedule through February 1954. Based on experience to date, three tests per week, consisting of three releases per test, represent the maximum rate at which tests can be conducted and data analzed to permit planning of subsequent tests. The actual number of tests conducted in a locality would in all probability fall short of these optimum operations if unsuitable weather conditions, a shortage of part-time personnel, transportation problems, or other unforeseen difficulties were encountered.

It is planned that mesometeorological surveys will be conducted continuously in both Minneapolis and St. Louis. Such surveys in Minneapolis will be interrupted late in May or early in June in order to use the meteorological equipment in Winnipeg prior to and during tracer tests there.

TABLE II - 5

TRACER TEST SCHEDULE THROUGH FEBRUARY 1954

St. Louis -- Summer 1953

20 May - 1 July -- 18 Tests, 54 Releases

Winnipeg -- Summer 1953

10 July - 10 August -- 12 Tests, 36 Releases

Minneapolis -- Summer 1953

18 August - 15 September -- 12 Tests, 36 Releases

St. Louis -- Fall 1953 - Industrial Areas

9 November - 30 November -- 9 Tests, 27 Releases

St. Louis -- Winter 1954

1 December - 20 January -- 20 Tests, 60 Releases

Minneapolis -- Winter 1954

27 January - 26 February -- 12 Tests, 36 Releases

A trip is to be made to Ottawa, Canada, in May to meet with the Defense Research Board to discuss all phases of the proposed program in Winnipeg. It is anticipated that this trip will furnish information regarding operation of a business in Canada, including requirements for customs inspection and employment of Canadians by a U.S. company. If tests in Winnipeg are assured, it is planned that representatives of The Ralph M. Parsons Company will go to Winnipeg late in May to obtain operating space, hire, and train personnel, and begin the meteorological phase of the program. These surveys will continue through the tracer test program. Specific test sites will be chosen from the analysis of the initial meteorological surveys. Arrangements will be made for the transportation of exposed filters to Minneapolis for analysis.

In the event that Winnipeg tests are not authorized by the Chemical Corps or approved by the Canadian Defense Research Board, or if for any other reason the tests cannot be arranged to be conducted during the desired summer season, the summer tests in St. Louis and Minneapolis may be extended accordingly.

Fig. II-1

Two Meter Air Temperature Survey Crew in traverse car showing map reader, crew captain and driver, and meter reader.

Fig. II-2

Wiresonde Crew, showing balloon captain at cable reel. Balloon locating light is on tripod. Temperature indicating bridge is in automobile in background.

Fig. II-3

Flow rating the filters to be used in samplers prior to a test.

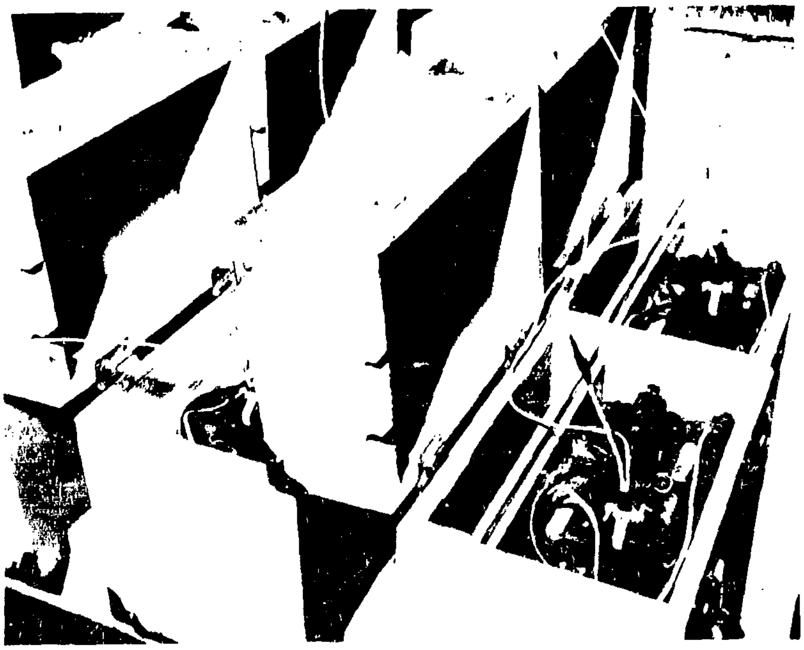

Fig. II-4

Batteries on Charge, showing sampler pumps removed and method of connections of wiring.

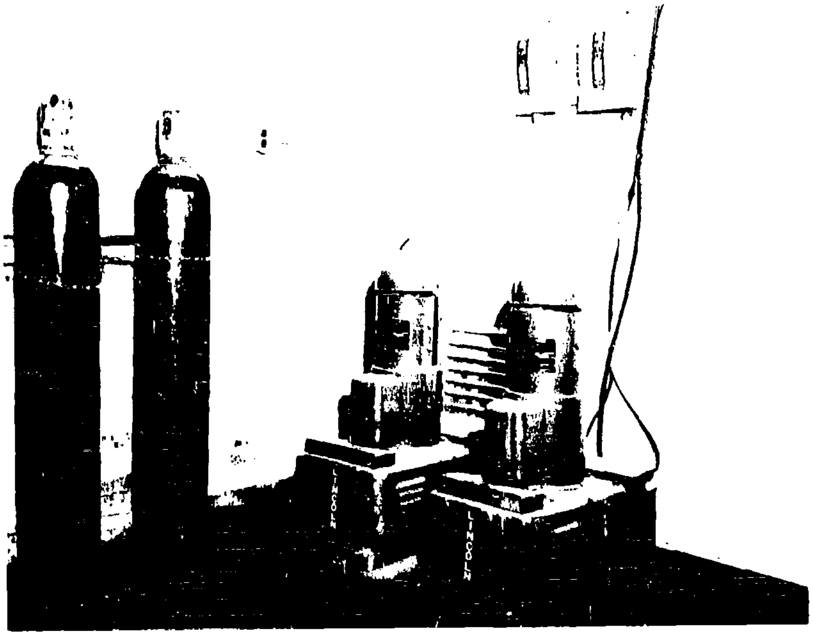

Fig. II-5

Two Automatically Controlled Generators used for battery charging.

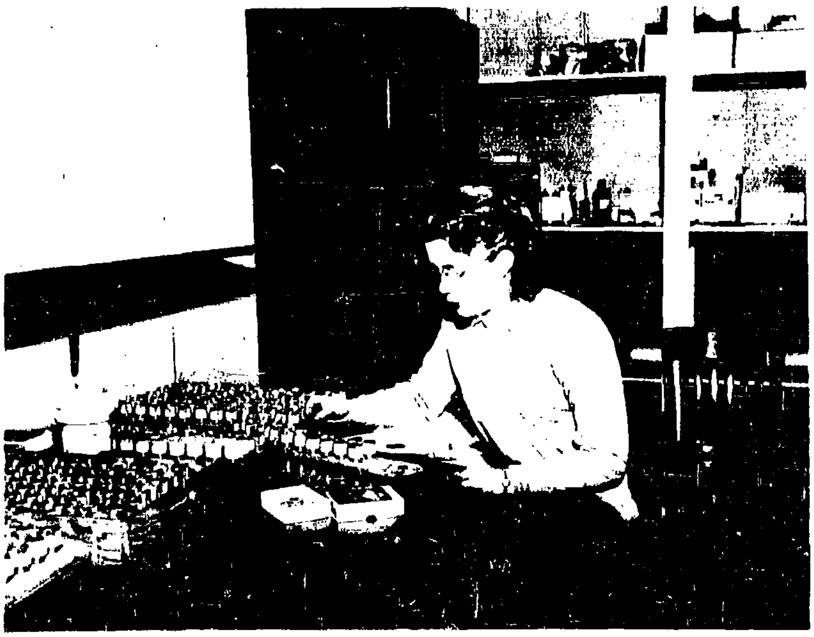

Fig. II-6

Inserting new membrane filters into holders in the laboratory.

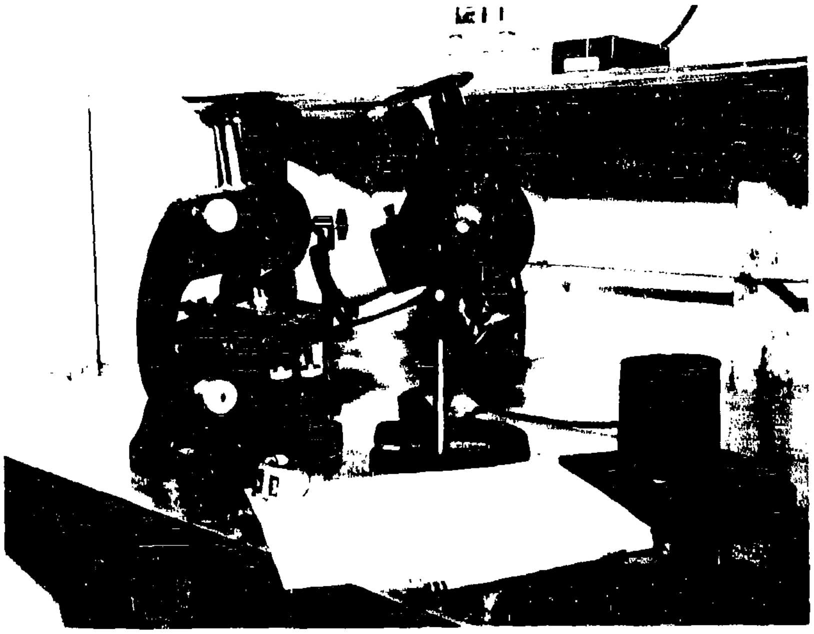

Fig. II-7

Typical Counting Station, showing microscope, ultraviolet stage illuminators, set of eyepieces and auxiliary illuminator.

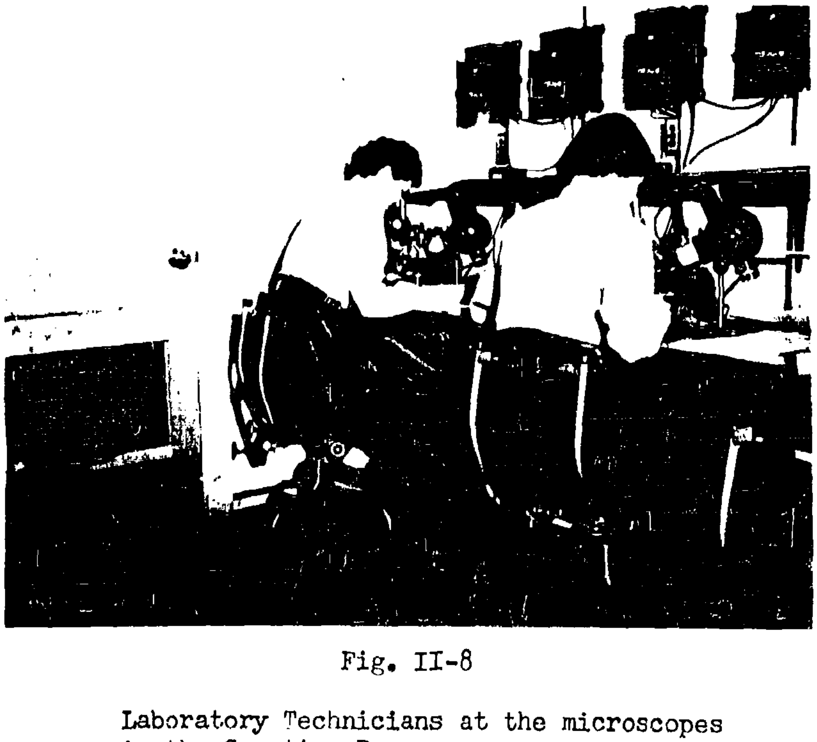

Fig. II-8

Laboratory Technicians at the microscopes in the Counting Room.

III. INSTRUMENTATION

A. GENERAL

At the end of the period covered by this report, practically all instrumentation has been completed and delivered to the field. The only exceptions to the above statement are the time sequential drum impactor and the wind velocity recording units. Both of the latter items are now in the production stage and the first deliveries are scheduled so that some quantities of these items will be available for summer operations in the St. Louis area.

Continuing the practices established in previous Joint Quarterly Reports, two additional items of instrumentation are written up in following sections. These are the wiresonde temperature bridges and the portable membrane filter sampler including the pertinent accessories. Also included below is a section covering the observations on equipment performance by field personnel, the data for which have been obtained during the winter test program in the city of Minneapolis.

Future reports will continue to contain detailed write-ups on individual instruments, including laboratory and analytical equipment and techniques. These reports will also contain observations received from personnel in the field regarding operation and evaluation of instruments, in addition to a description of problems encountered and their solution.

B. FIELD OBSERVATIONS ON EQUIPMENT PERFORMANCE

The following represents a summary of the information received from the field office regarding the performance of instrumentation throughout the winter test period in Minneapolis. The pertinent data regarding each type of instrument are given under separate captions below.

1. Portable Membrane Filter Air Samplers

A quantity of 150 MF samplers were produced and shipped to Minneapolis in time for the winter test period. Operational experience with these units indicates that they are entirely suitable for their intended use, and actual reliability in the field averaged better than 97% under all conditions. During the severest conditions encountered which comprised an open area test at an ambient temperature of -16° F, a total of 3 out of 120 samplers set out failed because of mechanical or electrical malfunction. This represents an actual reliability of 98.5%, which can be considered as a conservative estimate due to the fact that some data were obtained prior to the complete failure of the three units mentioned. In general, all components selected for these units proved reliable, and every evidence was given that this equipment will continue to operate with a minimum of maintenance throughout the entire test program.

The major difficulty encountered was in the malfunction of certain of the Gast type AD 440-2 vacuum pumps. A total of 27 pump malfunctions occurred during the winter tests, the majority of which proved to be the result of foreign material getting into the pump body. Because of the nature of the foreign material, which generally proved to be small pieces of aluminum or iron, it was impossible to determine whether the failures were due to improper or incomplete inspection on the part of the pump manufacturer or to carelessness in handling during the assembly of the sampler units. In none of the cases mentioned above was the damage serious. A pump exchange service was arranged with the Gast Manufacturing Company of Benton Harbor, Michigan, which will assure prompt repair of defective units, a maintenance supply of spare pumps, and, therefore, the availability of a full complement of samplers for any test.

The 6 volt DC Kendrick-Davis motors used to power these pumps operated with 100% reliability throughout the winter tests. However, in view of possible future contingencies, a repair and exchange arrangement was established with the Kendrick-Davis people on a basis similar to that arranged with Gast. The Willard 12 volt aircraft batteries providing prime power for these units also performed admirably and no operational casualties occurred.

During a typical field experiment at Minneapolis, a group of 188 pump filter combinations involving 94 pumps was flow rated both before and after a 4 hour operating period. The mean change between the initial and final rates amounted to a decrease of 3%, and only 11 of the pump filter combinations deviated by more than 10% from their initial flow rates, which altogether averaged 10.4 liters per minute.

Some slight difficulty was encountered with the plastic dust covers used for the protection of the filter holders. The original filter holder design had a knurled body over which the plastic caps fitted, thereby offering both mechanical protection and assuring freedom from contamination of the filter. Under low temperature conditions, it was found that the plastic dust caps tended to contract to the place where the removal from the filter holders was extremely difficult. A further complication ensued when it was determined that in the removal of the caps small shreds of the plastic were scraped off. In several cases minute pieces of the dust cap material fell on the face of the filter and exhibited fluorescent properties under ultraviolet illumination. This phenomenon created some difficulty in the counting of particles although not to the degree that the accuracy of the count was impaired. This condition was alleviated by a redesign of the filter holder which eliminated the knurling and slightly reduced the outside diameter. This minor design change now permits easy removal of the dust cover under conditions of low temperature and eliminates any possibility of scraping extraneous material on the filter face.

The magnetic filters themselves and the quick-connect couplings used in the sampling unit proved to be both reliable and operationally desirable. As a result of tests made on the first filter holders produced, which indicated some air leakage around the ring magnet, all subsequent models have the magnet imbedded in a sealing compound which successfully prevented the recurrence of this difficulty. The provisions made for charging batteries without necessitating their removal from the sampler case, and the battery charging equipment itself, proved satisfactory in every respect, and a complete recharge of all batteries may be made in time to permit the running of a complete sampler array on alternate days.

2. Portable Temperature Indicating Bridges

Sixteen of the portable temperature indicating bridges were completed, as well as the 22 aspirated automobile mountings and 4 aspirated aircraft thermistor mountings. The temperature bridges themselves were operationally satisfactory with the exception of several minor features. A plywood writing panel was substituted for the aluminum panel originally provided because of the difficulty encountered in handling metal parts at below zero temperatures. The only other modification required was the substitution of 6 volt DC automobile power for the 3 volt internal batteries originally used for both instrument and chartboard illumination. Personnel in the field found that the use of 6 volt light bulbs provided and arranged for power for the higher voltage lamps by the simple expedient of plugging the circuit into the cigarette lighter on the automobile instrument panel, thereby eliminating the necessity of increasing the size and weight of the battery required in the portable equipment.

As of the end of the current period, no flight test has been conducted in the field using the aircraft thermistor mountings. Laboratory tests at Stanford University, however, indicated that some slight modification in design would be desirable in order to provide better radiation shielding for the thermistor elements. Therefore, the aircraft mountings in the field were recycled through Stanford and modified to incorporate this latest change in design.

As mentioned in JQR 2, the original automobile aspirated thermistor mountings, of which six were constructed, failed to withstand the structural shocks imposed on the equipment by the extremely rough streets and inclement weather conditions prevalent in the Minneapolis area, even though exact duplicates of this equipment had been found satisfactory for use in Palo Alto. Therefore, 16 additional units of heavier mechanical construction were produced. These modified units withstood the rigors of the winter test program in excellent fashion and appear to have eliminated any possibility of future difficulties. The remaining problem with the automobile mountings resulted from factors which are not under the control of operating personnel. These include the infinite variety of bumpers and bumper guards encountered on the automobiles of part-time personnel. A serious problem thus arises, due to the need for obtaining a large number of various types of bumper brackets and trailer hitches. Another problem in this connection was the somewhat fragile bumper-attaching brackets provided on late model automobiles. The excessive flexure of the automobile bumper and its attaching brackets resulted in tilting the aspirator mast from vertical.

3. Wiresonde Temperature Measuring Equipment

The wiresonde temperature measuring equipment consists of the temperature measuring bridge, the thermistor elements and protective cage, the cable reel, and the lifting device which, in the case of Minneapolis, was a Kytoon. The only serious equipment problems were the freezing of the wiresonde batteries and the reel bearings. The former problem was capable of easy solution by actually operating the bridge itself either within a building or a heated automobile or truck. The latter problem was successfully solved by reaming the bearings somewhat oversized and by the use of low temperature lubricants such as Prestone 200 or Yukon oil.

The major problem in wiresonde operation was the result of high wind conditions which effectively prevented the use of this equipment during many of the tests. Some thought has been given to a practical solution to this problem, but no feasible answer has appeared which would allow use of the wiresonde equipment under conditions of high winds or extreme turbulence. With respect to turbulence, the rapid temperature fluctuations which occurred during wiresonde observations under such conditions posed several questions. In many cases temperature readings could not be taken because of violent meter fluctuations. In other cases the average temperature changes reversed without any apparent cause. In a series of tests conducted in Minneapolis during the winter months it was definitely established that both the fluctuations and temperature reversals were true measurements of an actual phenomenon caused by the inhomogeneity of the upper air unier turbulent conditions. The test results are considered conclusive and indicate that in every case the equipment was performing in its specified manner and within its established limits of accuracy.

Field evaluation of the balance of the instrumentation will be included in future reports.

C. PORTABLE MEMBRANE FILTER SAMPLER AND ACCESSORIES

One of the primary pieces of equipment required for conducting tracer tests was a rugged, portable piece of air sampling equipment for obtaining quantitative measurements of the simulant materials. The fundamental design criteria for this equipment were established by personnel at Stanford University, based on their theoretical and experimental background and on the results of tests in the Palo Alto and San Francisco areas. The general requirements as established included the following:

1. The pumping unit must be capable of providing a minimum flow of 7 liters per minute of free air through a 16 millimeter diameter deposition area of a membrane filter.
2. The holder for the filter must be constructed so as to permit ready loading and unloading of the filters and must provide a secure air seal of a type which could not result in damage to the filter membrane itself.
3. The equipment must be capable of satisfactory performance over an ambient temperature range of -40° F to +115° F.
4. The final design of the equipment should represent the maximum in portability and ruggedness and must be capable of operation by relatively unskilled part-time personnel.
5. Provisions should be made for the rapid interchange of filter holders to permit multiple testing to be accomplished by a single unit.
6. The entire equipment should be packaged in a rugged case capable of withstanding extremely rough usage and having provision for

locking the equipment cover and securing it by means of a chain to prevent theft.

7. The equipment should be inconspicuous in appearance so that use of large numbers of these units in heavily populated urban areas will not excite undue attention.

The equipment as finally designed and produced has successfully met all of the above requirements. As seen in Figs. III-1, III-2, and III-3, the portable membrane filter samplers consist essentially of a vacuum pump and battery mounted in a 3/4 inch thick marine plywood box. The box dimensions are 14 inches in height, 13 inches in width, and 9 inches in depth, with the complete equipment weight including a fully charged battery being in the neighborhood of 35 pounds. The equipment is built in three sections as shown in Fig. III-3. The pumping unit, the control panel, the filter holder, and vacuum hose are contained in a single unit which plugs into the top section of the lower half of the case. The bottom of the case contains a battery compartment and a hose storage compartment. The lid section is attached to the lower half of the case by slip hinges which permit its easy removal for maintenance. The entire box is finished in two coats of a durable, weatherproof enamel of an inconspicuous neutral gray color. Metal corners are provided for the protection of the box, and the lid is secured by means of two trunk type latches which contain provision for locking by use of a padlock chain combination. The pump deck contains a Gast AD 440-2 vacuum pump which is powered by a Kendrick-Davis 6 volt DC motor. This unit is shock mounted on two Lord vibration mounts and is equipped with both an input and output filter unit. The purpose of the Lord mountings is to minimize mechanical noise rather than for any vibration protection of the unit. If the pump were mounted directly on the panel, the sounding board effect would raise the noise level to an objectionable value.

The input filter section is a safety device to prevent abrasive or foreign material from entering the pump chamber when the unit is operated without a filter holder and membrane filter. The output filter section acts as an acoustical muffler and is very efficient in the reduction of the high frequency acoustical sound level. A manual petcock is provided on the output of this acoustical muffler as a means of regulating the air flow as desired. The control section contains a DPST on/off switch, a standard cartridge type fuse for battery protection in case of a direct short, and a polarized accessory outlet which can be used to provide 6 volt DC power for either lights or the operation of other units as required. Provision is also made in the deck for the storage of four filter holders. This entire unit fits into a recessed section in the lower half of the case and connects with the battery by means of a four prong Jones plug. The vacuum hose is permanently attached to the pumping section and is stored in a separate compartment immediately adjacent to the battery when the unit is assembled.

There are no mechanical or electrical devices contained within the lid other than a sponge-rubber covered hold-down block which secures the filter holders in position when the lid is closed, and two openings with metal closures which permit the hose and an electrical line to be brought out from the box with the lid closed and locked.

The battery chosen for this unit is a Willard aircraft type AW 12-25. The batteries as ordered from the Willard Battery Company were specially constructed in the form of two 6 volt cell groups which are connected in parallel to provide power for the operation of the pump. This battery was chosen because of its desirable form factor, relatively high efficiency, and physical characteristics. It is of the spillproof type which is necessary to prevent damage to any of the equipment from battery acid should the sampler case be overturned. Further protection is provided by a manifold which conducts the battery gases from each cell to the outside of the box through a small grilled opening in the side of the case. As arranged, the battery may be charged without the need for removing it from the sampler case as shown in Figs. III-4 and III-5. This procedure is accomplished by equipping a battery charging bus with male Jones plugs corresponding to the type installed on the pump unit. This feature saved considerable time in the field as it permits the pump and hose to be removed and the case and battery to be taken directly to the charging room.

One of the most critical parts of this equipment is represented by the filter holders. The membrane filters used are a cellulose ester membrane and are extremely fragile mechanically. Experience proved that any rotational force applied to this type of filter may result in tearing of the filter and making it unusable. Also, this mechanical weakness requires that a secure backing be provided which will have the dual capability of providing mechanical support for the filter without introducing any undue violent disturbance of the incoming air stream.

The two factors mentioned above, combined with the necessity of maintaining an air seal around the periphery of the filter to assure that all air drawn through the pump passes through the 16 millimeter diameter active filter area, resulted in considerable study being expended on the design of the final configuration arrived at are shown in Fig. III-6. The essential parts of the filter holder as shown in this photograph are the filter holder body, the membrane filter, the metal retaining ring, and a plastic dust cap.

The filter holder body consists of an inner section surrounded by an Alnico Number 5 cast magnet which is covered by a protective aluminum outer sleeve. The top surface of the magnet is ground flat and is positioned .002 inch above the surface of a 100 mesh monel screen which acts as a backing for the filter. In operation the filter is placed on the magnet and screen surface, and the soft iron washer is laid on the filter face. The surface of the washer is ground flat, and the magnetic attraction between the magnet and the washer provides an air seal around the periphery of the filter. A slot is milled in each side of the outer sleeve to allow easy removal of the washer. The plastic dust cover can be placed over the entire assembly giving both mechanical and contamination protection to the filter. The base of the filter holder was machined to fit a Wiggins quick-connect vacuum coupling. This permits filter holders to be connected and disconnected from the Wiggins fitting provided at the end of the vacuum hose in a matter of ten seconds or less. The ability to make rapid changes of filter holders in the field proved to be extremely valuable. The use of the magnetic principle for the provision of an air seal also permits rapid loading and unloading of filter holders in the laboratory and minimizes damage to the filter media itself either before or after exposure. The maximum pressure drop through the entire vacuum system including the filter holder without filter, the vacuum hose, and the input filter to the pump averaged less than one inch of mercury at 14 liters per minute free flow.

Representative pump flow and filter flow characteristics are shown in Fig. III-7. The flow rate and pressure drop corresponding to the point where the two curves cross represents the expected values for the combination of filter and pump; other units will have a similar but not identical curves.

Fig. III-8 shows how the flow rate and current drain of the complete sampling unit changes with battery voltage. Over the useful battery life, nominally 50 ampere hours at voltages varying from 6.6 to 5.4 volts, it will be seen that about nine hours of operation may be expected, with the flow rate varying from 9.6 to 8.4 liters per minute. At low battery temperatures, of course, the performance will not be as good but will still be satisfactory.

In operation the amount of hose required may easily be fed out through the port provided in the side of the box. In many cases only the filter holder itself is exposed as indicated in Fig. V-8. Where the filter holder is exposed through the window of an automobile or positioned at the two meter level, the full seven feet of hose provided may be used, as shown in Figs. V-9 and V-10 respectively.

D. A MODIFIED ALNOR VELOMETER, JR. FOR MONITORING BATTERY OPERATED SAMPLERS

Since the battery operated sampling units were designed in the interests of portability with no automatic means of regulating the air flow to a standard value, it is necessary to keep track of the flow through each individual filter in order to enable calculation of total dosages from filter counts. The Alnor Velometer, Jr. (Illinois Testing Laboratories, Chicago, Illinois) furnishes a good basic instrument capable of responding to a moderate pressure drop across the intake and outlet apertures, and hence may be modified to form a compact flow meter.

This instrument, see Fig. III-9, is used to measure wind speeds by facing the inlet port into the wind, thus allowing an air flow through the instrument. This air flow impinges on a pivoted vane and deflects it to a position where the restoring force provided by a coiled hair spring is equal to the deflecting force. The design of the vane housing permits the instrument to be read as an almost linear function of wind speed over most of the scale. Therefore, when modified, the instrument is capable of being used as a flow meter having a quite linear scale deflection as a function of rate of flow. The instrument can be held in any position, and it is well damped because of the lightweight construction of the balanced vane and pointer.

This flow meter, illustrated in Fig. III-10, is provided with an adapter head which fits over the filter to be flow rated. A cemented rubber ring making contact with the hold-down ring of the filter gives a leakproof connection. The air drawn in through the filter enters from the outside through the inlet holes in the crosspipe and the stream divides, mostly flowing through the orifice between the crosspipe and the adapter head. The remaining fraction of the air flows through what was formerly the inlet port of the Velometer to produce the deflection corresponding to the measured flow rate, and then enters the adapter head through what was formerly the outlet port.

Because of the use of common inlet holes in the crosspipe, the reading is not affected by high ambient wind speeds. The holes are made so large that even if the outer one is accidentally blocked, such as by the operator's gloves, the reading will be practically unaffected.

The size of the metering orifice is chosen so that the useful range of the flow meter will be from 2 to 15 liters per minute, graduated at intervals of .5 liter per minute. Since these graduations are quite open, the flow rate may easily be read to the nearest .1 liter per minute and the absolute calibration at 70° F is considered to be good to plus or minus 0.2 liter per minute. Since the pressure drop across the flow meter at 10 liters per minute is only .25 cm of mercury, an estimated 1% change in flow rate will be occasioned by addition or removal of the flow meter from the pump filter system.

In the preparation of the direct reading scale, each instrument is calibrated at a number of fixed points (determined by a set of critical orifices) against a Fischer-Porter Triflat Flowrater, and a smooth plot is made of the deflection in terms of the original 0 to 40 mph scale as a function of flow rate. From this plot a new scale is hand drawn with lines at the 1 liter per minute and .5 liter per minute intervals.

The modified Alnor Velometer, Jr. flow meter, which may be referred to as a shunted vane flow meter, gave very satisfactory performance and offered a more rapid and reliable means of checking large numbers of filter-pump combinations (see Section IV) than the liquid type flow meters previously used. Figures II-3 and V-14 show the flow meter in actual use at Minneapolis during flow rating of a large group of samplers.

E. WIRESONDE THERMISTOR AIR TEMPERATURE MEASURING EQUIPMENT

1. Requirements and Features

In the present mesometeorological studies, the vertical temperature profile of the air at various localities plays an important part as an indicator of the expected rate of diffusion of gas and aerosol clouds. The equipment described below fulfills the need for a measuring unit which may be readily moved from place to place. Under ideal conditions it will give readings significant to the nearest tenth degree Fahrenheit and will cover a range of altitudes from a few inches to nearly 1000 feet above the ground.

The device consists of a cage-protected Western Electric Number D176980 bead type thermistor element, a hand operated cable reel with provision for suspending the cable and thermistor from a Kytoon or cluster of 100 gm meteorological balloons, and a deflection indicating Wheatstone bridge unit containing a stable battery operated vacuum tube amplifier. In the interests of portability and simplicity, automatic recording is not employed. Therefore, at least two operators are required; one man attends to the balloon cable, varying the altitude of the thermistor, and the other reads the bridge and records the indicated temperatures as a function of height and time.

The following characteristics of the D176980 thermistor make it well suited for this type of measurement: bead diameter, .013 inches; resistance, 75,000 ohms at 25° C; temperature coefficient, 4.3% resistance change per degree Centigrade at 25° C; dissipation constant in still air, 0.12 milliwatts per degree Centigrade rise in still air; thermal time constant, 0.5 seconds.

Photographs of the unmounted thermistor bead and the protective cage are given in Figs. III-11 and III-12, respectively. Because of the samll physical size of the bead itself, the rate of response is rapid as compared to other temperature sensing elements of equal ruggedness and stability. The small size also enhances the unit area heat-transfer characteristics of the bead and hence permits it to be relatively free from radiational heating and cooling even when used unshielded and without aspiration. The fact that aspiration of the sensing element is not used in the present equipment greatly simplifies the cable and balloon requirements since only a minimum load need be supported by the balloons.

The lift required from the balloons is further reduced by the use of a lightweight balloon cable: 1000 feet of Plastoid fiber glass insulated three strand Number 30 copper, capable of supporting 100 pounds. This small copper size is made permissible by virtue of the comparatively high resistance and large temperature coefficient of the thermistor bead.

The high resistance of the thermistor bead does offer one drawback in that a film of condensed moisture on the end of the glass stem between the supporting wires (see Fig. III-11) will offer a shunting path across the bead and cause the instrument to read incorrectly. Therefore, it is intended for use only at less than 100% relative humidity.

Although the internal temperature of the dry cells constituting the power supply to the bridge circuit and amplifier should not be allowed to fall below about 20° F, the calibration ranges of the instrument extend from a nominal -10° F to +120° F.

2. Additional Characteristics of the Thermistor Sensing Element and its Means of Support

The mechanical means of supporting the thermistor bead, involving four 1/8 inch sections of .001 inch diameter platinum wire, make it essential to protect it during handling and use from any possible contact with the lead wires, balloon cable, or leaves and twigs near the ground. The weight of the bead itself, however, is so small that the sensing element is not vulnerable to transmitted mechanical shocks.

The protective cage consists of a six sided piano wire framework ending in a loop at the top for attaching the balloons and silver soldered to a brass sleeve at the bottom for holding the lucite adapter in which the glass stem of the thermistor unit and external flexible leads are held by casting resin. The wire spacing is sufficiently open to avoid spurious effects from radiational heating or cooling of wires. These effects, of course, would be most pronounced under still air conditions.

Although relatively few beads have become casualties in the field either from mechanical damage or from escape by balloon, this possibility together with the extent of the individual variations in resistance temperature characteristics of the beads led to the decision that it would not be worthwhile to attempt to make the bridges accurately direct reading. At the present stage of development, this would require an undue amount of time for individually adjusting the resistors for a particular thermistor bridge. Moreover, because of the limitations of the allowable measuring current which may be passed through the thermistor without exceeding the permissible temperature rise, some sacrifice in the desired linear relationship between bead temperature and bridge indication must be made or the voltage sensitivity of the vacuum tube amplifier must be increased to the point where the zero drift is apt to become great enough to interfere with maximum ease of use under rigorous field conditions.

Therefore, although the direct readings give an approximate idea of the course of the indicated temperature changes, these readings must be subsequently referred to calibration tables before the true temperatures are obtained, and two or three thermistors used with a single bridge may differ in direct readings by several degrees Fahrenheit before the corrections are made.

The fast response time of the bead thermistor is considered desirable in vertical traverse work where the altitude of the thermistor varies rapidly, although the naturally occurring temperature fluctuations at any constant level may cause greater apparent difficulty in assigning a definite air temperature to that level than if a more slowly responding sensing element were used. The extent and rapidity of these fluctuations are in themselves an indication of the mesometeorological conditions and, even though stated qualitatively, are a useful addition to the temperature-height data.

3. Bridge Circuit.

The simplified bridge circuit of Fig. III-13 has a number of features in common with the bridge circuit developed for the 14-B aspirated thermistor air temperature indicator described in Section III, JQR 2. The VTVM (vacuum tube voltmeter, i.e., the amplifier plus the Weston Model 301 0 to 50 microammeter) may be switched (Sw_2) across R_9 and adjusted to a 45.0 μa indication by R_{adj}. in order that the ratio of bridge current to VTVM sensitivity may be kept constant. This feature is even more important in the case of the wiresonde bridge than in the case of the aspirated thermistor bridge since the sensitivity of the unbalance indicator, now the combination of the 0 to 50 microammeter and the vacuum tube amplifier, is more likely to show variations with time and instrument temperature and among the different units due to manufacturing variations in the vacuum tubes.

The purpose of the voltage-dividing resistor series R_{51}, R_{52}, R_{31}, R_{32}, etc., is to reduce the bridge current to fulfill the following two conditions:

a. That the I^2R thermistor heating at any temperature on any range not exceed .25° F in still air and

b. That on Ranges 1, 2, 3, and 4, the temperature difference corresponding to a deflection change from 0 to 50 microamperes be close to 25° F, and that on Range 5 a temperature difference corresponding to the 0 to 50 microampere range be close to 50° F.

Fulfilling these conditions allows the bridge to be nearly direct reading in conformation to the 0 to 50 graduated meter scale on all ranges, and also, for Range 5 permits the thermistor heating current to be kept small enough to fulfill requirement "a".

The balancing resistor series R_1 through R_5 is so chosen that the bridge will give zero deflection at, respectively, -10°, +10°, 30°, 50°, and 70° F, based on the expected 200 ohm cable resistance and the design mean temperature-resistance function curve of the group of thermistors originally ordered.

The VTVM unit is a balanced two tube circuit employing a pair of dry cells operated Raytheon CK 502 AX hearing aid tubes; in Fig. III-13 it is merely denoted by a block symbol. The absolute sensitivity varies from .55 to .65 volts required for a full scale reading and the plot of applied emf against meter deflection in microamperes is not quite linear, but is fairly reproducible despite variations in battery voltage.

Before the bridge is put into operation, and at suitable intervals thereafter, the zeroing button Sw_3 is depressed and the VTVM indication set at zero by means of an internal variable voltage source controlled by a zeroing knob on the panel. The rates of drift of the VTVM unit and of the bridge battery B_1 supply voltage, are so small, especially above freezing ambient temperatures, that the zeroing procedure (which must obviously be done first) and the bridge current adjusting procedure need be repeated only at 15 minute intervals or greater after the bridge has been in operation for the first five minutes.

The finished bridge unit, with the case opened into operating position, is shown in Fig. III-14. The upper hinge on the control panel allows it to be raised for battery changing. It will be observed that there are three pairs of terminals for attachment of thermistors; pair No. 1 is normally connected to the bridge, and pairs No. 2 and No. 3 are temporarily connected by pressing the appropriate buttons. This allows simultaneous observations of air temperature at the balloon altitude, at the base level, and, if the equipment is operated on a roof top, of temperatures down to ground level. Figure III-15 shows an interior view of the instrument case with the batteries in place but not connected. The space under the clipboard is available for storing the thermistors in their cages as well as the panel lights.

4. Wiresonde Reel and Balloon Attachment

The wiresonde reel (see Fig. III-16) is operated by means of a hand crank, and wraps the cable around a 6 inch diameter flanged drum. The fixed end of the cable terminates at an outside connector block connected to well insulated brass slip rings from which silver contact brushes make connections to the bridge terminals. This provision enables the thermistor bead resistance to be read at any time during ascent or descent of the balloons as well as when the reel is stationary by the cam-operated brake shown at the lower right. Terminals under the slip ring housing provide electrical connections to the three cable wires.

In normal operation one lead of the balloon cable is connected to the balloon reel stand which is in turn connected to a good electrical ground and also to the grounded side of the thermistor bridge instrument case. This procedure reduces the shock hazard occasioned by nearby power lines and in addition reduces the sometimes large effects of radio frequency pickup from nearby broadcasting and television transmitters. For certain cable lengths this effect has, on occasion, completely vitiated the bridge readings until proper grounding was installed; strong radio frequency voltages, despite the presence of bypass capacitors across the bridge input terminals and across the grid circuit of the vacuum tube amplifier, have in these cases blocked the amplifier so that it would no longer respond properly to the D.C. unbalance emf from the bridge circuit. This condition has been easily detected by the peculiar and fluctuating behavior of indications, and has not jeopardized the reliability of the temperature profiles.

The manner in which the thermistor cage is inserted between the cable and the balloon cord is shown in Fig. III-17. The cable strain is transferred by means of grooved Bakelite rings around which the cable is wrapped several times and then secured with tape and string. A heavy clamping pressure is not applied to the cable because it has been found that there is danger of distorting the interior plastic insulation and short-circuiting the copper wires.

The peripheries of the Bakelite spools also tend to distribute the points on the cable at which the copper is most subject to continual flexing. To safeguard against parting of the cable at the point of strain, the lower spool is attached to a jumper wire which bypasses the thermistor cage and is attached independently to the balloon cord. Thus, it is only the upper spool, to which the looped thermistor leads are attached, that normally takes the strain, while the lower spool and jumper act as a stand-by.

A Kytoon, which is normally used with the wiresonde equipment rather than balloons, is shown in Fig. III-18. The Kytoon, being a special form of airfoil balloon, has better lift characteristics and stability at high wind speeds and offers less horizontal drag than round balloons. The one illustrated, a Dewey and Almy Kytoon "8000", displaces 82 cubic feet, is 126 inches long by 51 inches in diameter, and has 4 to 6 pounds of lift at a 5 mph wind speed.

5. Calibration and Accuracy

Since the bead type thermistor and its leads are directly exposed, the bead thermistors are not calibrated by direct immersion in liquid baths but are mounted in a liquidproof brass tube container which is immersed in the constant temperature bath. The reference temperature is read by means of frequently calibrated No. 30 copper-constantin thermocouples mounted close to the beads. A slow stream of helium (for better temperature equilibration) is passed through a coiled copper tubing heat exchanger surrounding the brass container, then through the bottom of the container, and finally out through the one-half inch Lucite tube which also brings out the thermistor and thermocouple leads. This tube extends from the top of the brass container, kept about two inches below the level of the bath, to a height of ten inches above the surface. In this way appreciable heat exchange between the interior of the container and the room air is prevented, and by virtue of the approximately equal response times of the thermocouples and thermistor beads, accurate calibrations are possible even if slow drifts occur at the low temperature when the bath is not thermostatically controlled.

Temperature resistance data are generally taken at 115°, 90°, 32°, about 0°, and about -20° F and translated into resistance values for even 5° F intervals from -40° to +115° F. The method is similar to that described in Section III of JQR 2 for the 14-B thermistor aspirated air temperature indicator. The bridge unit is then calibrated by substituting for the thermistor a precision dial resistance box which is set in turn to the known thermistor resistance values at the 5° F intervals. The deviation of the bridge indicated temperature from the even 5° F intervals is recorded and translated into a correction curve.

Since no attempt is made to equalize the temperature resistance characteristics among a group of thermistors and since the VTVM sections of the different bridge units have characteristics which may depend on the individual tubes used, each bridge indication of temperature must, for translation into air temperature, be referred to a correction curve applying to the particular thermistor and the particular bridge used.

In the field, frequent comparisons between the corrected bridge readings and concurrent readings taken with a sling psychrometer will insure against serious inaccuracies due to failing batteries, moisture, and contamination on the thermistor bead and its support, stray electrical leakage, and partial component failures in the bridge indicating unit.

6. Performance in the Field

It is possible for a two man crew in favorable weather to unload the entire equipment from a station wagon or walk-in van and to make the wiresonde runs. For the sake of more rapid operation, for operation in gusty winds, and when the ambient temperature gets below 20° F, a larger crew is desirable.

At low temperatures all operations become more difficult, especially with gloves on, and the bridge itself must be kept in a heated car to prevent the batteries from freezing. By making use of a larger crew successful operations have been conducted at Minneapolis down to the limit of the lowest range, -10° F, of the bridge, and several of the bridges were subsequently modified to extend the range down to -25° F. Figure II-2 illustrates the cold weather operation of the wiresonde by a four man crew.

In the interests of safety both of operating personnel and of chance finders of escaped balloons, only helium, not hydrogen, is used for filling the balloons. Since this is rather expensive, it is standard practice to store and handle the Kytoons in the inflated or at least partially inflated condition.

Also for reasons of safety, certain electrical hazards in the operation of the wiresonde equipment must be recognized and dealt with. Before setting up the equipment at a new location, a thorough survey is made to locate any high tension wires in the vicinity, and if these are present the maximum allowable balloon altitude is set at very conservative safe limits, dependent upon anticipated variations in wind speed and direction.

If the balloon cable should break so as to leave the balloon pulling its lead wire across country, there would be the danger of someone innocently taking hold of the trailing wire while it is draped across a high tension line. Therefore, the maximum tension to which the cable will be subjected is kept well below the rated 100 pound minimum breaking strength, and operation in strong winds is avoided, particularly when the temperature profile is of secondary interest.

In practice, it is found that the altitude may usually be determined with sufficient accuracy from an experimentally determined table in which the balloon altitude is given as a function of the elevation angle of the balloon measured at the reel location and the length of cable paid out as indicated by coded markings on the cable. Allowance is made, of course, for the distance beneath the balloon at which the thermistor cage is suspended. In daylight the balloon's vertical angle is measured by a simple clinometer reading to the nearest degree, and at night an automobile spotlight mounted with altitude-azimuth dials is centered on the Kytoon.

Additional reference to the wiresonde operations is made in Section II of this report, and some of the wiresonde data are presented in Section V. On the basis of the experience gained in collecting and applying these data, it may be said that the equipment in the form described here represents a practical and useful instrument for mesometeorological investigations.

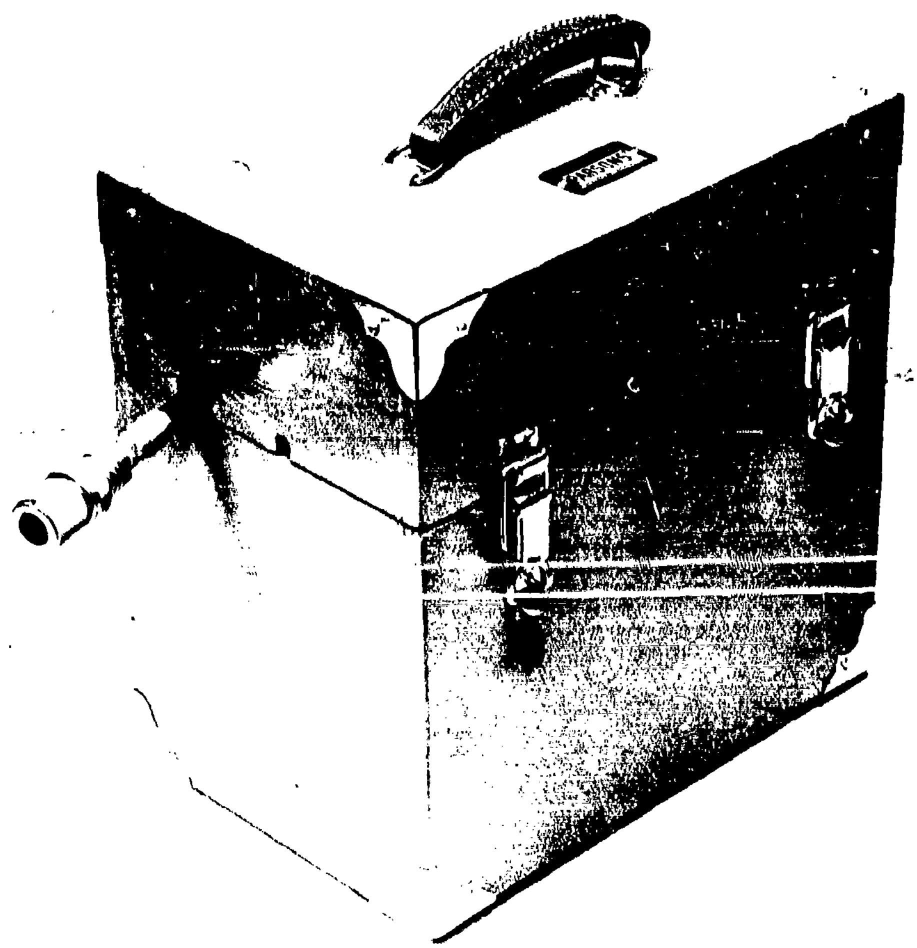

Fig. III-1

Portable Membrane Filter Sampler in operating condition. During transportation and storage, the exposed filter holder and hose are returned inside the case; the entire unit is self-contained.

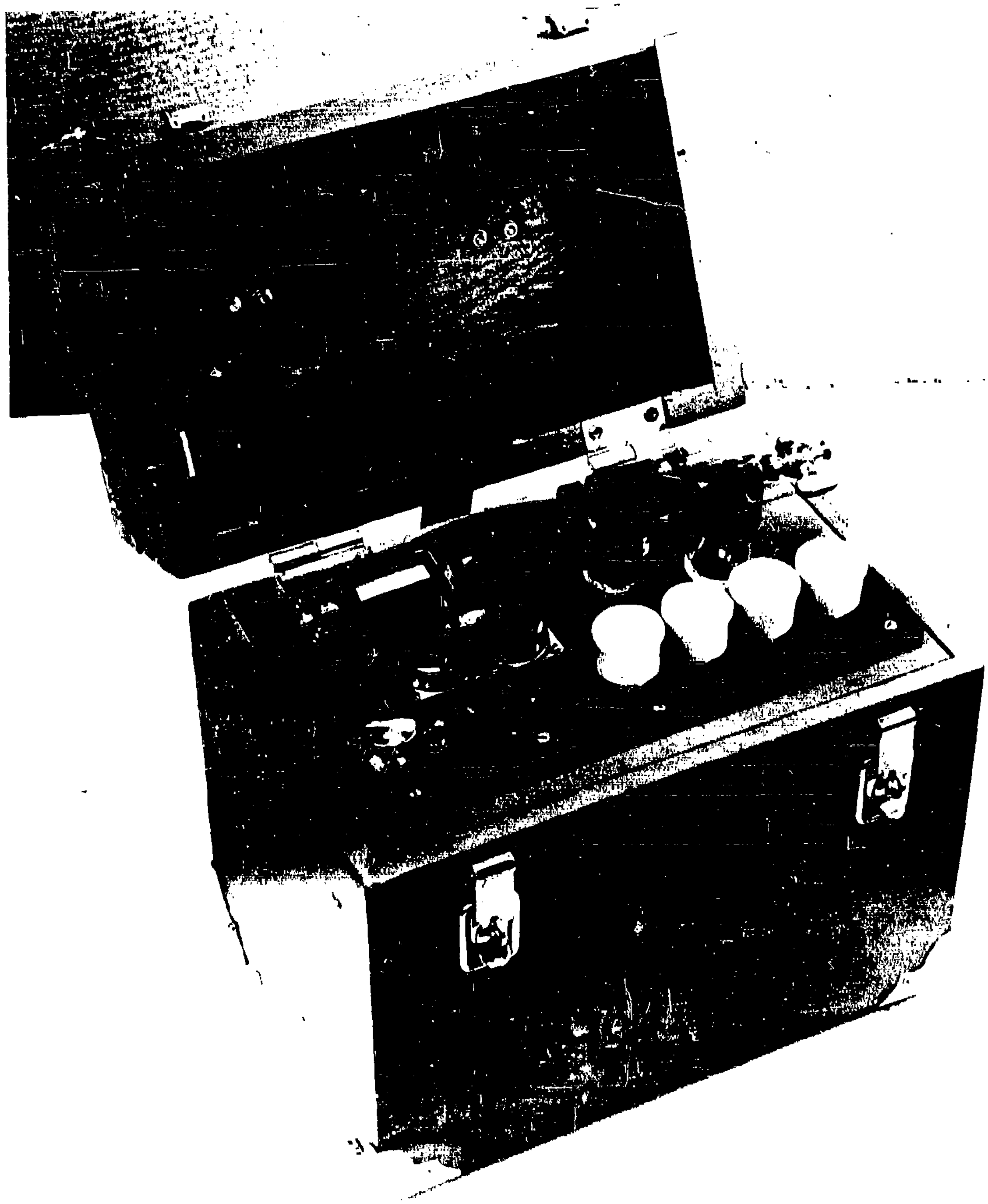

Fig. III-2

Portable Membrane Filter Sampler, opened for field servicing.

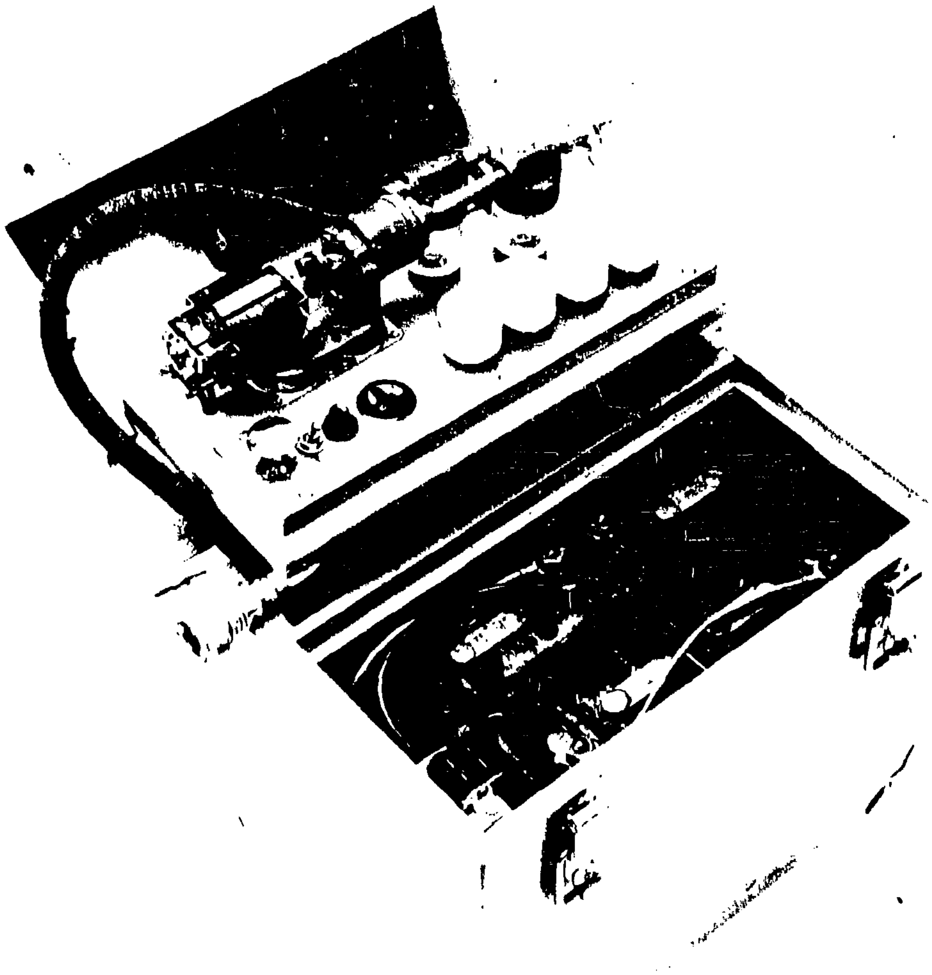

Fig. III-3

Portable Membrane Filter Samｃler, with lid section detached for battery charging and maintenance.

Fig. III-4

Batteries in Sampler Units being charged without removal from sampler boxes.

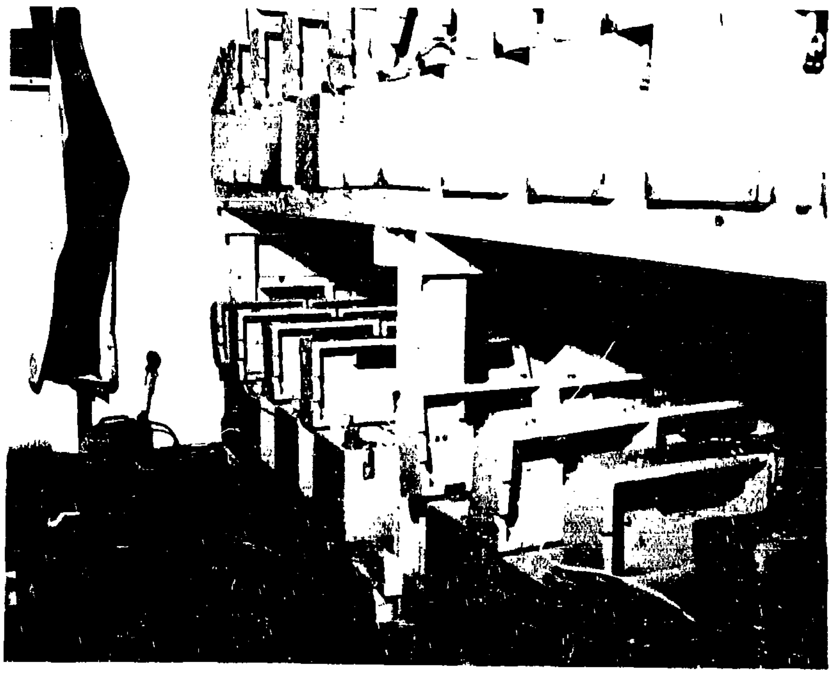

Fig. III-5

Array of Sampler Units with batteries on charge.

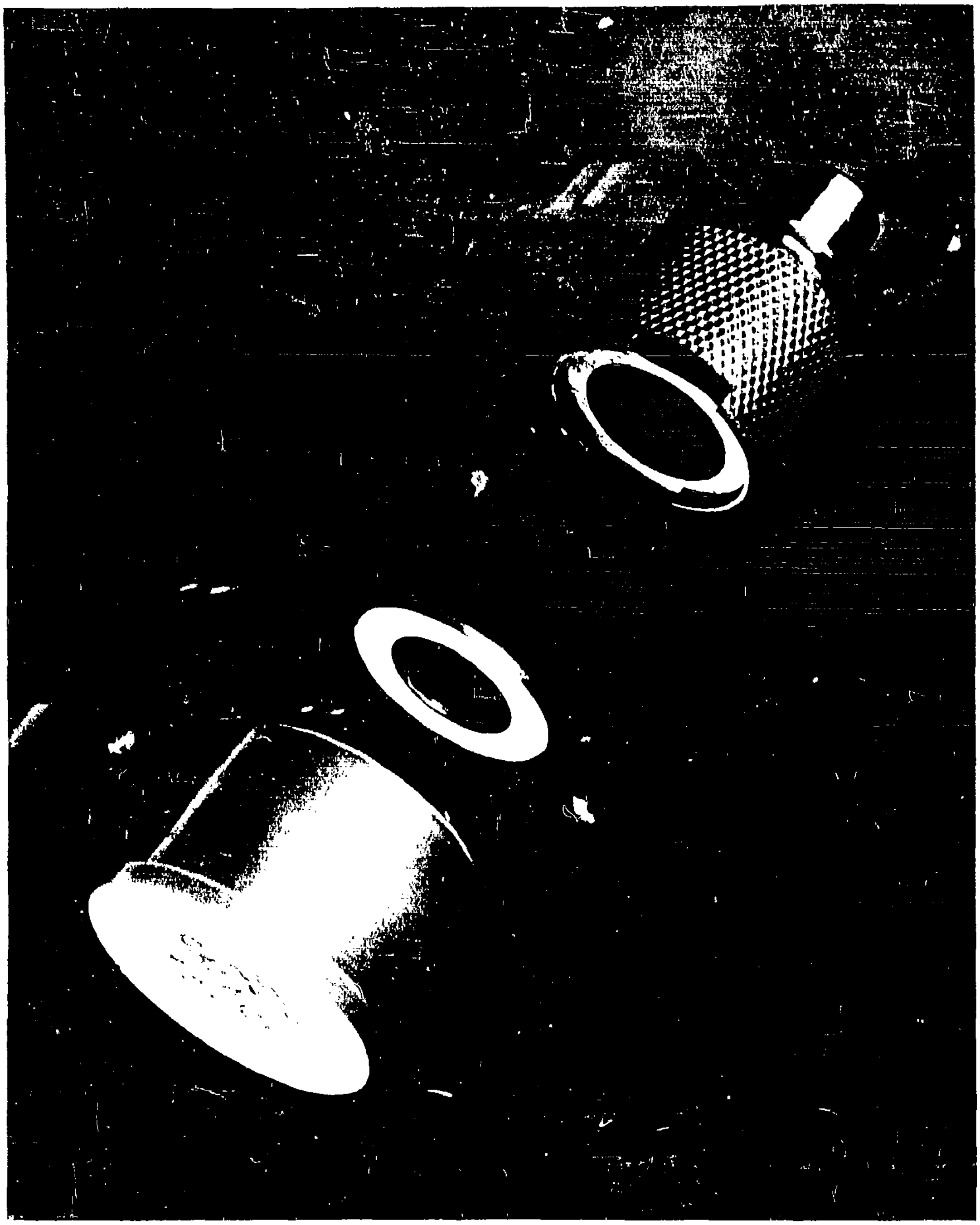

Fig. III-6

Magnetic Filter Holder Body, Membrane Filter, Retaining Ring and Dust Cap.

FIGURE III-7

PUMP FLOW CHARACTERISTICS AND FILTER FLOW CHARACTERISTICS AS MEASURED ON PARTICULAR UNITS

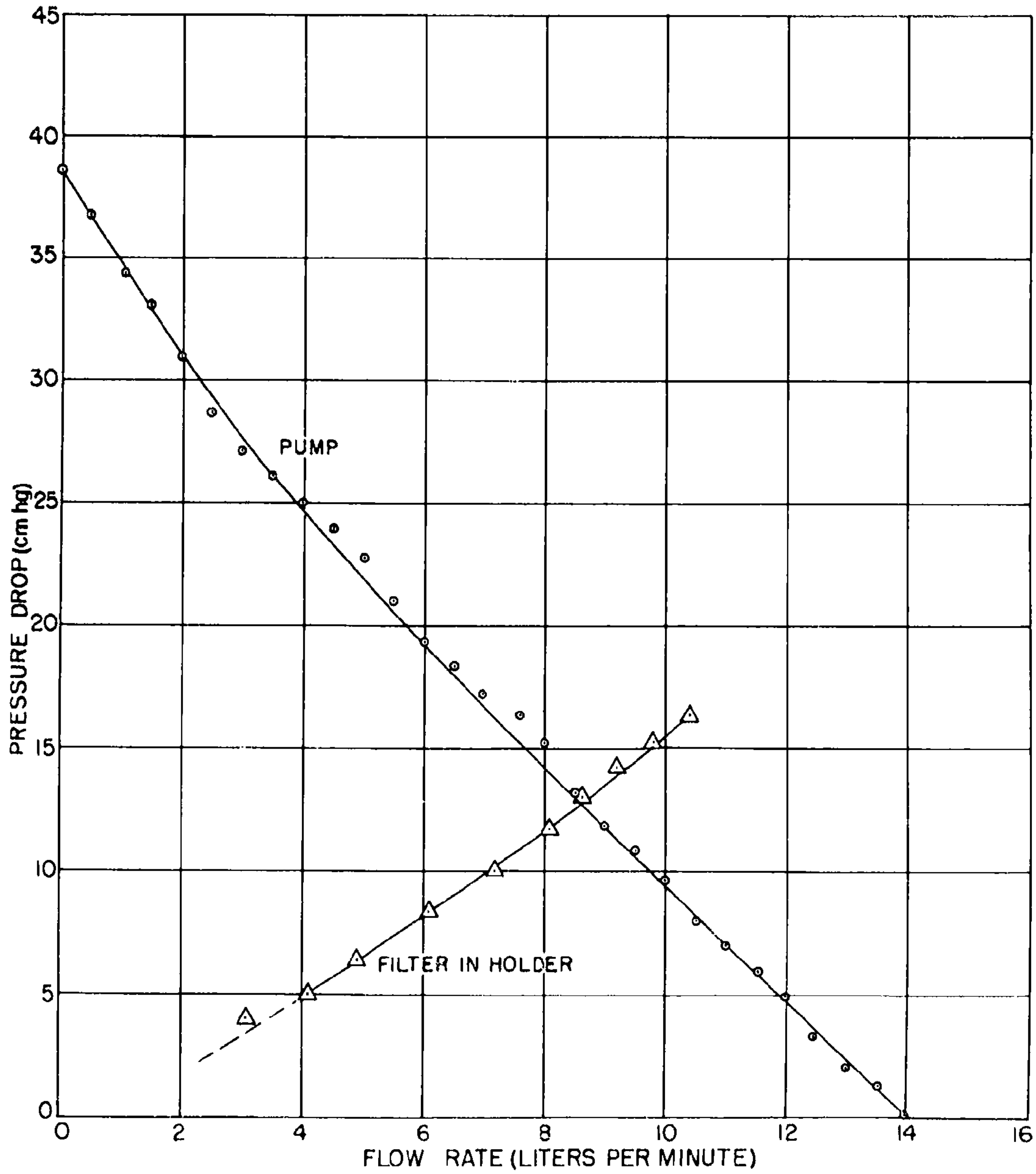

FIGURE III-8

FLOWRATE AND CURRENT DRAIN OF A PARTICULAR PUMP – FILTER COMBINATION AS A FUNCTION OF BATTERY VOLTAGE

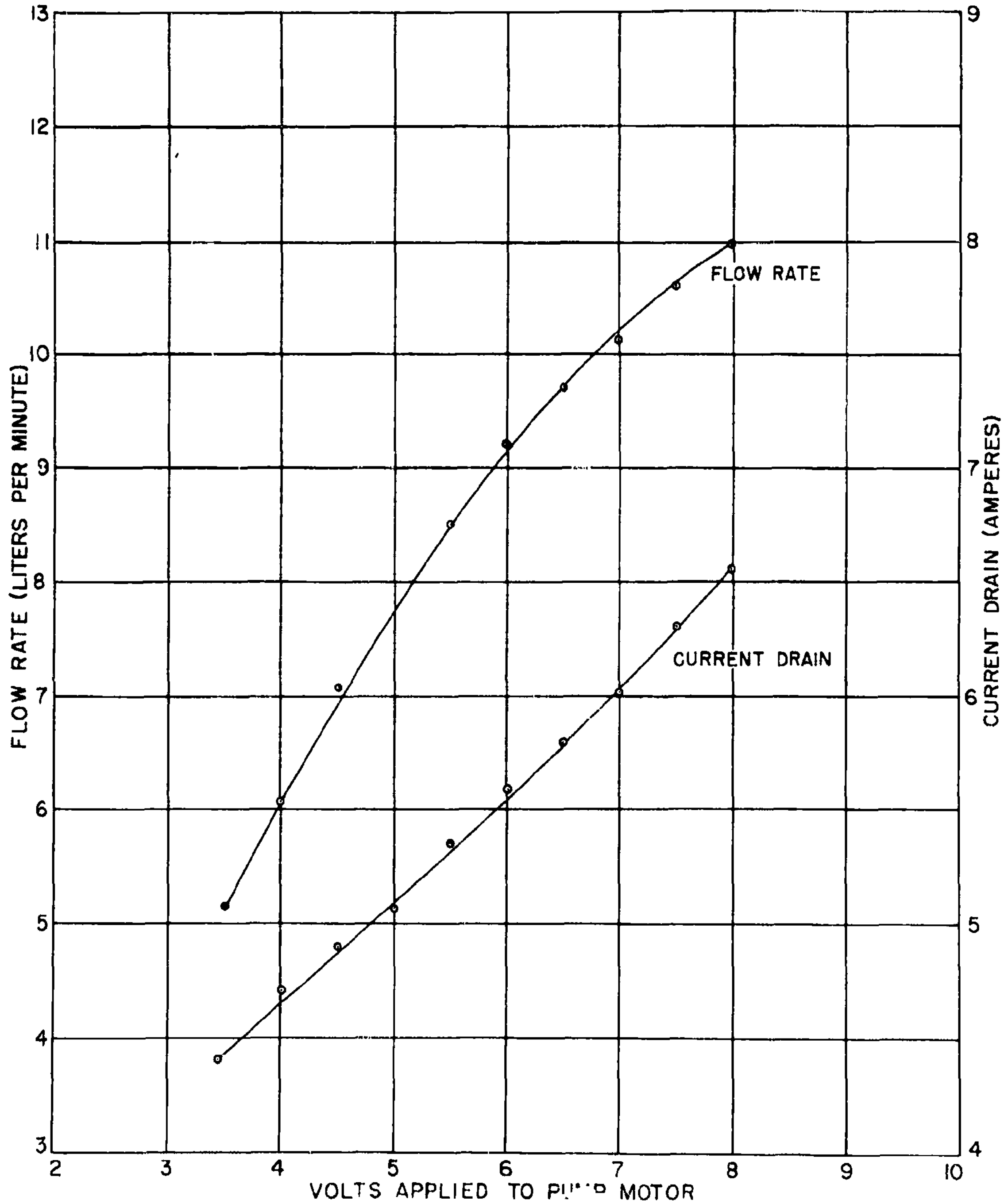

Fig. III-9

Alnor Velometer Jr. Anemometers, showing inlet port, left, and outlet port, right.

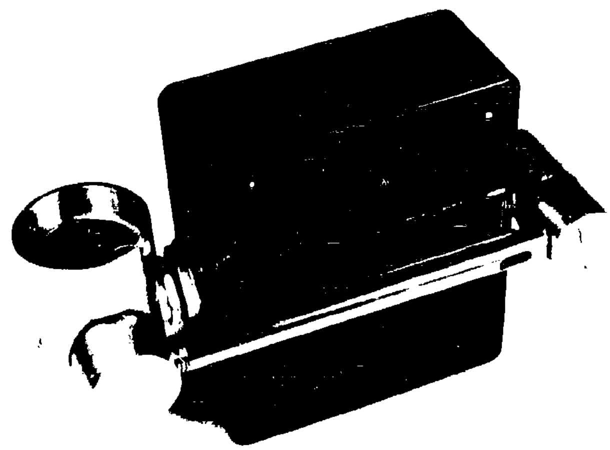

Fig. III-10

Back view of Shunted Vane Flowmeter, consisting of modified Alnor Velometer Jr. Anemometer.

Right; communication to former outlet port, and common inlet hole in crosspipe. Left; adapter head, with communication to crosspipe and former inlet hole. Meter in inverted position to show details of adapter head.

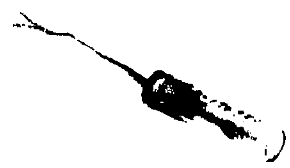

Fig. III-11

Western Electric D-17690 Bead Type Thermistor, used as wiresonde temperature sensing element (shown in shipping container).

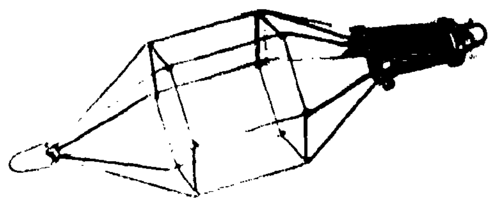

Fig. III-12

Protective Cage for Bead Thermistor, to be inserted in balloon line.

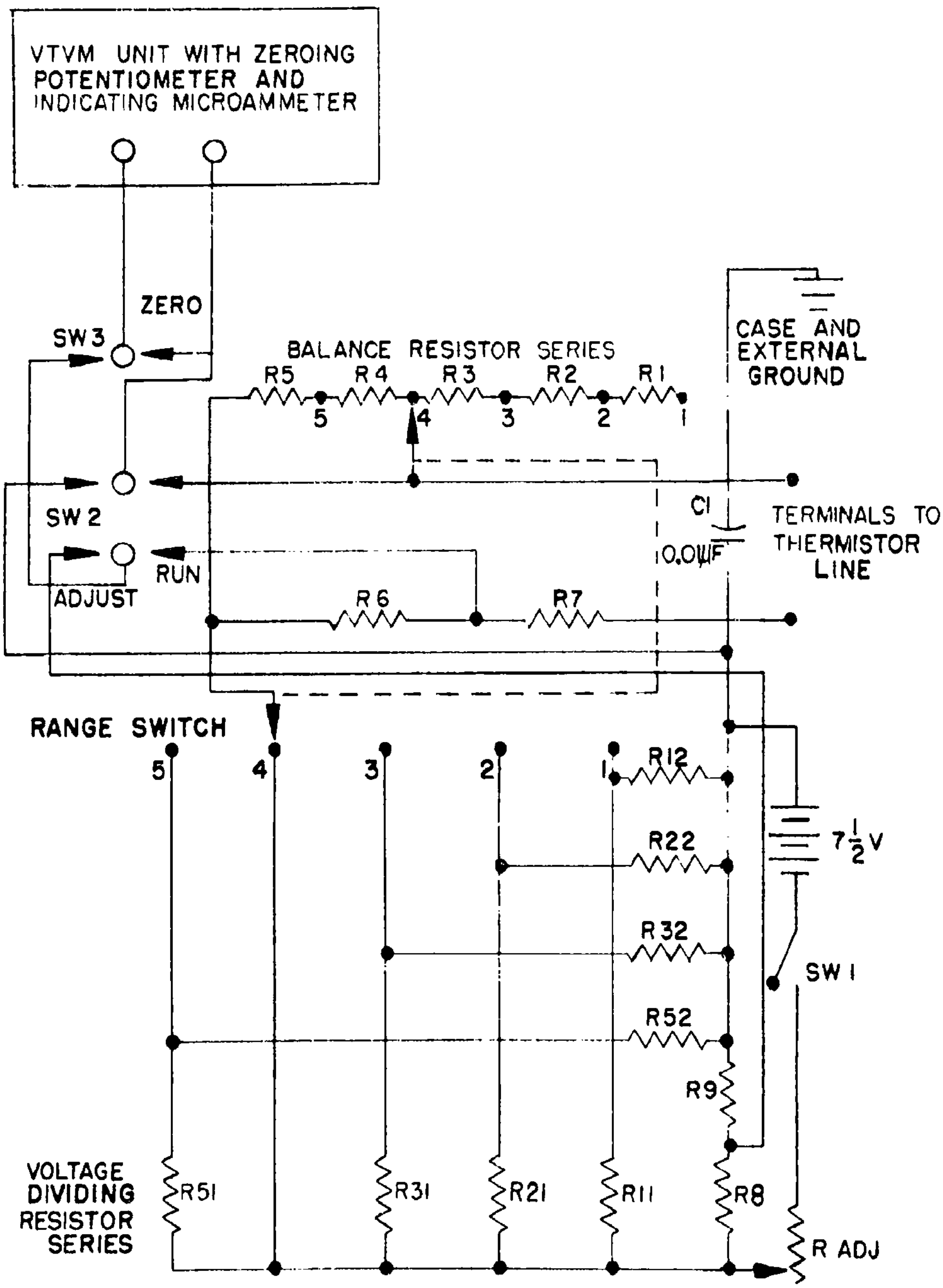

FIG III-13

SIMPLIFIED SCHEMATIC WIRESONDE BRIDGE CIRCUIT

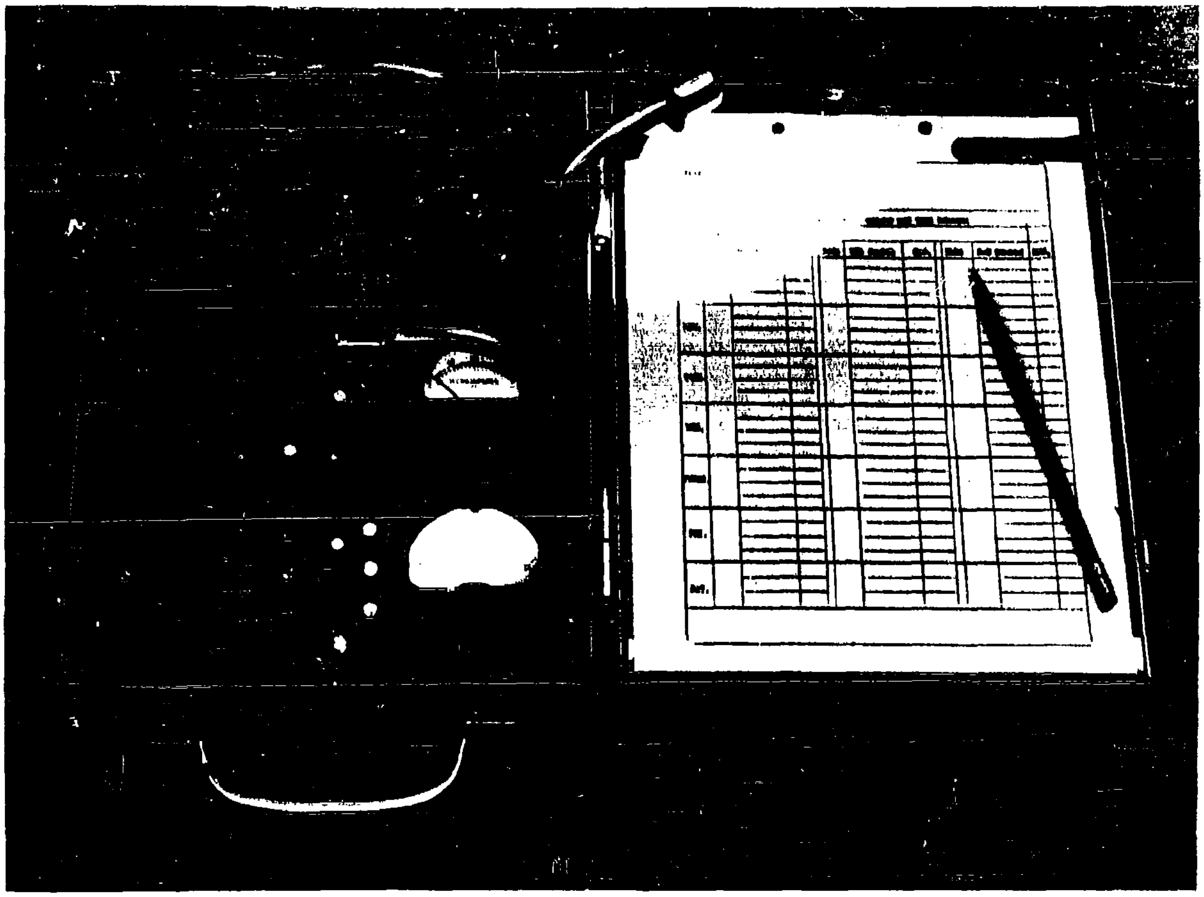

Fig. III-14

Wiresonde Bridge with case opened out for data recording. The adjustable panel lights proved useful during night operations.

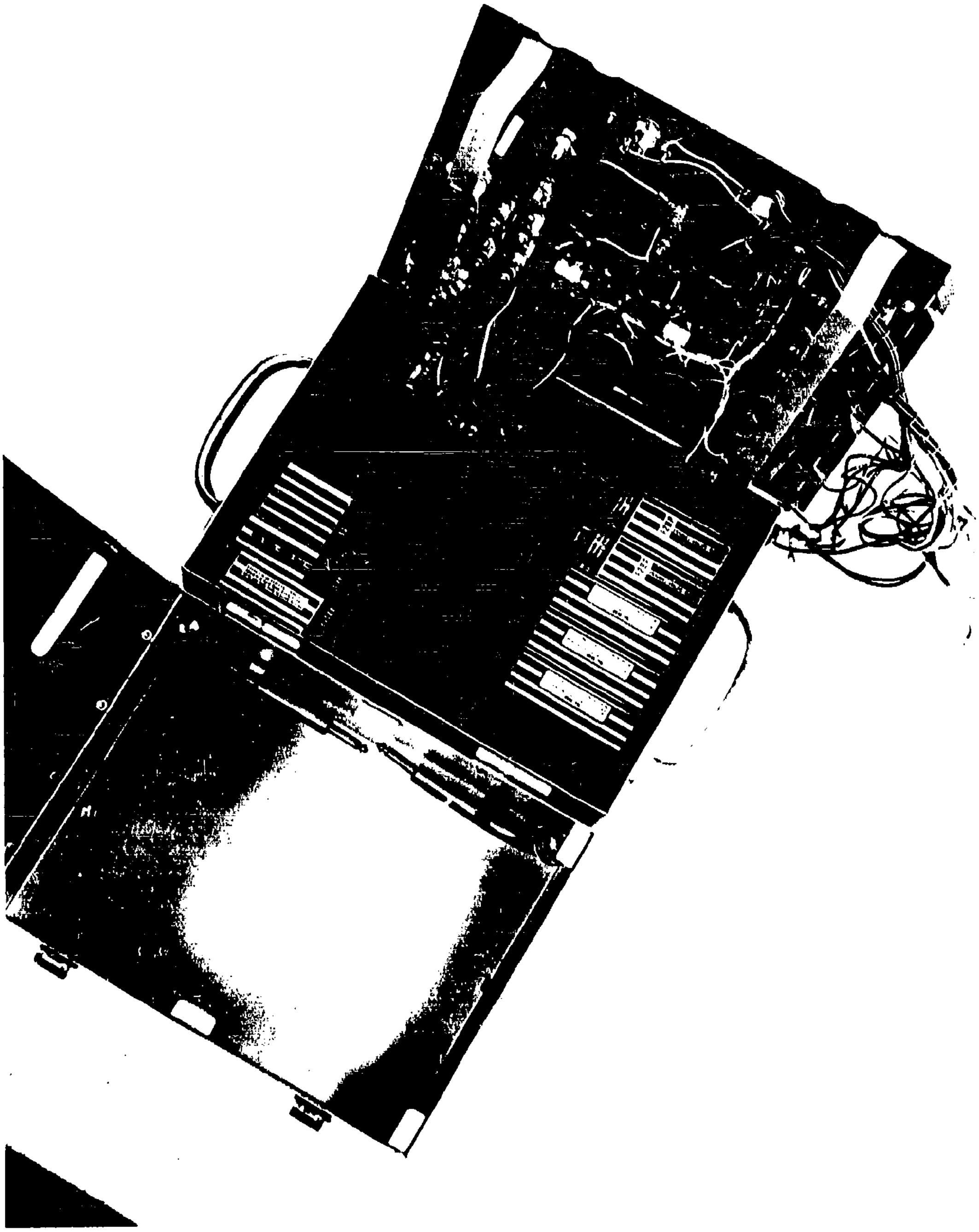

Fig. III-15

Interior View of Wiresonde Bridge Instrument Case with panel and clipboard opened out.

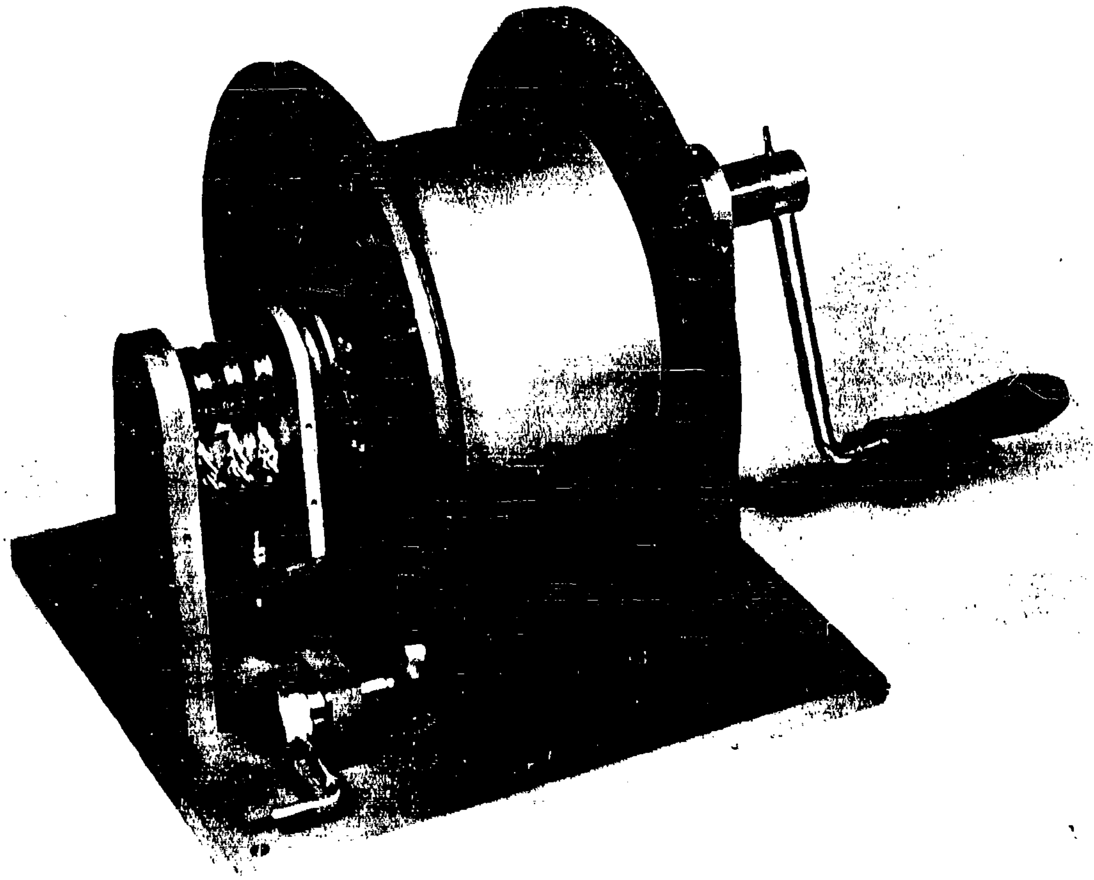

Fig. III-16

Wiresonde reel with slip ring cover removed.

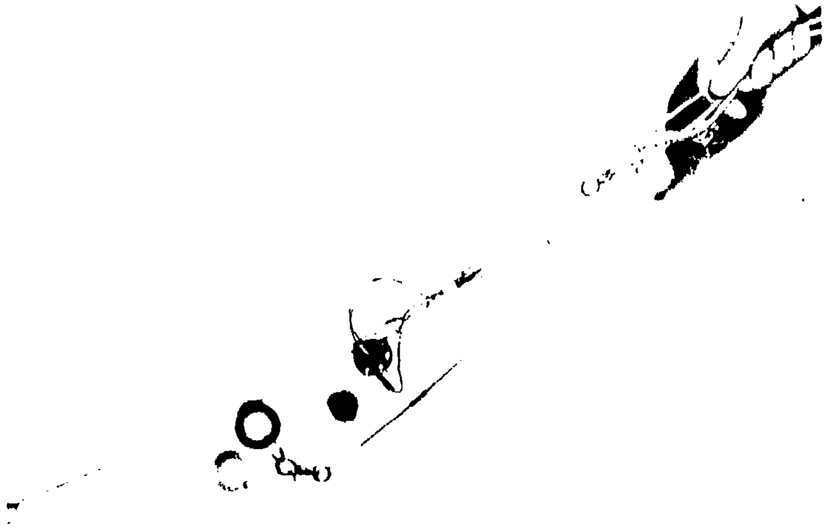

Fig. III-17

Method of Attachment of Balloon Cord (upper right), and Thermistor Cage to Wiresonde Cable.

Fig. III-18

Kytoon, used with wiresonde equipment, under storage conditions, with reserve helium supply.

SECRET
SECURITY INFORMATION

FIG. IV-1

TOPOGRAPHIC MAP ST. LOUIS

CONTOURS AT 20 FOOT INTERVALS ARE SHOWN IN BLACK.
TEMPERATURE SURVEY ROUTES ARE SHOWN IN RED.

IV. TEMPERATURE SURVEYS IN ST. LOUIS

A. CITY STRUCTURE AND TERRAIN

St. Louis, with a population of more than 856,000, is located on the western side of the Mississippi River, near its conjunction with the Missouri River. Running parallel with the river, from north to south, are the railroad tracks and yards. Also running from north to south between the river and Broadway, is the heavy industrial complex. The Monsanto Chemical Company, for example, is located in this area. As one approaches the river, going east from Broadway, the ground drops moderately. Throughout the city the elevation varies from 400 to 605 feet above sea level.

Covering an area of approximately 61 square miles, St. Louis contains about four square miles of inland water. Lakes and rivers are thus not as prominent within the City as they are in Minneapolis. Forest Park, covering an area of two square miles in the west-central section, is the largest of the 79 city-owned parks. South of the railroad tracks to Jefferson Memorial National Park, which faces the river on the east, is light industry from one to six stories high. Beyond the park the area becomes densely residential.

The downtown district is well defined. It consists of an area of 0.86 of a square mile, bounded by Delmar Boulevard on the north just above Jefferson Park, by railroad yards on the south, by Third Street adjoining Jefferson Park on the east, and by Twentieth Street on the west. It consists of multistoried buildings. No trees are found here except in the parks, and in this respect, too, St. Louis differs from Minneapolis.

The east and west streets running west of the downtown district are commercial. Warehouses and light industry are found elsewhere, all one to three stories high. In the northwest area the commercial buildings are similarly one to three stories high. The area consists of many multiple dwellings except for one district of rehabilitated housing covering approximately 12 square blocks. Here the backyards are small. Near Fairground Park and beyond, housing is mostly single residences.

A secondary business district, including the leading theaters, is located at Grand Boulevard and Olive-Lindell. It should be noted that the main streets are predominantly commercial.

B. SUMMARY OF RESULTS

Between January and March 1953, 18 temperature surveys, in addition to the 17 reported for the preceding quarterly period, were made in St. Louis preparatory to selecting a provisional site for studying aerosol cloud behavior. The procedures and instruments for measuring the horizontal temperature gradient are detailed in JQR 2. Because of the major testing effort expended in Minneapolis and the resulting diversion of a limited supply of necessary meteorological equipment, no measurements were taken of the vertical temperature gradient. A summary of the 18 two-meter temperature surveys is included in Table II-3, Section II.

Of the 35 temperature surveys conducted in St. Louis since the inception of the current program, full evaluative attention is given in this report to four: to surveys M-1010 and M-1016, both of which were merely cited in JQR 2, and to surveys M-1020 and M-1024. In each survey, resulting in isotherm charts for 2000, 2100, and 2200 CST, an adequate network of representative data was obtained, although the area south of Tower Grove Park was not traversed. The first three surveys employed four cars each; the last survey, an additional car. Routes covered in the surveys are indicated in Fig. IV-1; they are based on the results of preliminary runs in this city and on the findings obtained in similar surveys of other cities, particularly Minneapolis. Since intensive coverage was not achieved, certain regions of uncertainty remain. Isotherms for such regions, as for comparable Minneapolis isotherms, have been drawn on the basis of experience gained from surveys conducted elsewhere and are indicated as dashed rather than solid lines.

For each of the four surveys, the applicable raob sounding obtained at Columbia Municipal Airport, the summary of the synoptic situation, and the isotherm chart or charts are presented in Appendix A. Of the twelve isotherm charts obtained from these surveys, seven are reproduced in the appendix, three for M-1010, two for M-1016, and one each for M-1020 and M-1024.

These particular isotherm charts were chosen for their comprehensive representation of the City under varying meteorological conditions. M-1010, for example, was selected to present a complete series of three traverses for one night, 5 December 1952, which was characterized by clear skies and relatively light winds. Survey M-1016, conducted eleven nights later, showed an extremely high temperature differential at 2100 hours, and a marked decrease one hour later. Whereas the 2100 isotherm map for M-1020 (8 January 1953) shows the influence of adverse weather such as cloudy skies with moderate winds and precipitation, the corresponding map for M-1024 (5 March 1953) shows an average typical night characterized by clear skies and light winds.

The prevailing meteorological conditions described above are listed in Table IV-1, which, for purposes of correlation, defines horizontal gradient measurements in numerical terms. The symbols used to describe the chart situations are defined in JQR 2 (pp. 68-69). Entries for other meteorological data, including survey clouds and diurnal temperature range, are also described in JQR 2. These data were obtained from continuous recordings made at Lambert Field, 10.8 miles northwest of the city. All wind instruments at the airport were located 59 feet above ground.

TABLE IV-1

SUMMARY OF DATA FROM SELECTED TEMPERATURE SURVEYS

GENERAL			TEMPERATURE SURVEY DATA					OTHER METEOROLOGICAL DATA					
								Wind					
								Airport		University			
Survey No.	Date	Time CST	$T_{Max.}$	$T_{Min.}$	D_T °F	$\bar{T}$ °F	$[R/\Delta T]$ Min. mi/°F	Dir.	Speed (MPH)	Dir.	Speed (MPH)	Survey Clouds	Temp. Range(°F)
M-1010	5 Dec.'52	2000	51.9	37.1	14.8	44.5	0.28	W	9	NW	5	Clear	21
		2100	51.3	37.8	13.5	44.6	0.23	W	5	NW	4	Clear	21
		2200	49.5	35.8	13.7	42.6	0.23	W	9	NW	3	Clear	21
M-1016	16 Dec.'52	2000	49.3	33.0	16.3	41.2	0.24	S	5	S	3	Clear	18
		2100	48.3	30.8	17.5	39.6	0.14	S	8	SSW	3	Clear	18
		2200	47.4	37.8	9.6	42.6	0.32	S	7	SSW	3	Clear	18
M-1020	8 Jan.'53	2000	31.8	27.9	3.9	29.8	0.42	NW	7	NNW	7	Low overcast*	0
		2100	32.0	27.8	4.2	29.9	0.45	NW	8	NNW	5	Low overcast*	0
		2200	32.8	28.8	4.0	30.8	0.42	NW	7	NNW	4	Low overcast*	0
M-1024	5 Mar.'53	2000	50.2	42.0	8.2	46.1	0.27	SE	7	SSW	5	Clear	23
		2100	50.1	40.8	9.3	45.4	0.15	S	9	SSW	3	Clear	23
		2200	51.0	37.9	13.1	44.4	0.18	W	8	WNW	5	Clear	23

* Sky was obscured above 300 feet

C. CHARACTERISTICS OF HORIZONTAL TEMPERATURE PATTERNS

1. Isotherm Patterns and their Reproducibility*

The two-meter isotherms over St. Louis show a consistent pattern on all nights. With clear skies and light winds the pattern is sharp and intense as shown by the 2100 CST map from M-1016 (Fig. A-6). Under adverse weather conditions the pattern fades as shown by the map from M-1020 (Fig. A-9). The warmest air is generally over the downtown district just west of the Jefferson Memorial, while the coolest air is over Forest Park and the outlying areas to the northwest of the city limits. The horizontal temperature gradients in the vicinity of the downtown heat island are frequently quite pronounced on the east or river side but are weak to the northwest. As indicated by the map from survey M-1024 (Fig. A-11), the gradient to the east was in excess of 6° F and only 1 to 2° F to the northwest. The temperature gradients in the colder areas are frequently quite intense on all sides. An extreme instance is shown by the 2100 CST map from M-1016, where horizontal temperature changes in excess of 10° F per 2000 feet were measured in the vicinity of Forest Park.

Although the temperature differential (D_2) varies markedly with the weather, the basic pattern persists under a considerable range of meteorological conditions and is therefore considered to be reproducible. In particular, the weak gradients in the tentatively selected test sites (see Section IV-E) are reproducible.

* All figures cited in this and the succeeding portions of the present Section are found in Appendix A.

2. Effect of Meteorological Parameters on the Isotherm Patterns

The primary effect of cloud cover and the secondary effect of wind speed are clearly illustrated by comparing the 2100 CST data from surveys M-1016 and M-1020 (Figs. A-6 and A-9). In the first case, on 16 December 1952, a near maximum value of D_T in excess of 17° F was obtained with clear skies and local wind speeds of 2 to 3 mph. But in survey M-1020, conducted on 8 January 1953, a near minimum value of 4° F was obtained with cloudy skies, precipitation, and local wind speeds of 4 to 7 mph. The $[\bar{R}/\Delta\bar{T}]_{min}$ values for the two surveys are also affected. Under clear skies and an average wind speed of 2.5 mph, a value of only 0.1 mile per degree Fahrenheit was obtained, but with cloudy skies the value exceeds 0.5 mile per degree Fahrenheit and wind speeds average 5.5 mph.

Since no survey has yet been made with clear skies and moderate to strong winds, it is impossible to evaluate completely the singular effects of wind speed on temperature. However, currently available data do not contradict previous conclusions that the city temperature differential decreases with increasing wind speed. The evaluation of wind speed effect is also complicated by the wide range in values obtained on a given night from the continuously recording instruments located at different sites and at relatively high elevations. In survey M-1016, for instance, varying wind speeds were reported for the following heights: 2 mph at ground level, 3 mph at roof top height in the University area, 6 mph at the 59 foot height (Lambert Field), and 18 mph at 303 foot height (Weather Bureau, city office).

Qualitative indications are that wind speed changes both the shape and location of the heat island. In M-1010 the warm area was quite elongated by the westerly winds, and weakening of the usual riverside gradient is largely explained by advection of warmer air eastward.

The immediate effect of a small change in weather conditions is clearly demonstrated by comparing the 2100 and 2200 CST maps from survey M-1016 (Figs. A-6 and A-7). On the 2100 map an intense D_T of 17.5° F existed; on the following map the D_T dropped sharply to 9.6° F. This decrease of nearly 8° F was occasioned by a decrease of 2° F in the warm areas and by a warming of nearly 6° F in the cold areas. Associated with this warming of the colder areas was a gradual increase in wind speeds at the airport and at the Weather Bureau, city office. It would thus appear that the wind shear of 12 mph, as evidenced between the 60 and 300 foot observations, was sufficient to weaken the strong but shallow inversion established early in the evening. This hypothesis is supported by the twofold increase in visibility at the airport, from five miles in smoke to ten miles unrestricted, and a local shift in wind direction from southeast to south-southwest.

3. Effects of Terrain

St. Louis terrain may be described as gently rolling country. From a low contour of approximately 400 feet paralleling the river, the land slopes upward to the west at a maximum rate of 100 feet in 4000 (Fig. IV-1). The highest spots in the city are a few knolls which just exceed 600 feet. With an elevation range of only 200 feet, it would thus seem that terrain effects are at a minimum. Such is the case in the downtown district and the associated area to the northwest, both lying mostly between the 450 and 550 foot elevations. In the Forest Park area, however, there are definite indications that on inversion nights the cold air favors the lowest ground even though the elevation differentials are only 50 to 100 feet. Another noticeable terrain influence is along the river's edge just east of the downtown district. These two effects are exemplified by the 2100 CST map from M-1016.

Within the city limits there are no lakes comparable in size to those of Minneapolis, although the City does include some four square miles of water area mostly east from the Mississippi River. Considerable water and marshy area on the eastern side of the river may have some influence under conditions of weak easterly winds.

4. Comparison with Other Cities

A comparison of St. Louis with Minneapolis or with the western cities studied earlier by the Stanford project shows that for its size, St. Louis has comparable intensities of horizontal temperature differential and temperature gradient. As Table IV-2 indicates, there is considerable similarity in the basic temperature patterns of St. Louis and San Francisco. Each has a downtown district less than a mile away from the water, and a large park approximately four miles to the west. Both also compare favorably in population density and maximum temperature differential. In one respect, however, St. Louis is unique. It is the only city so far studied that has such a high percentage of flat gradient area. The overall differentials persist, but even under the extreme cases of D_T, as in M-1016, the area to the northwest of the downtown district is relatively homogeneous.

TABLE IV-2

HORIZONTAL TEMPERATURE PATTERN CHARACTERISTICS

COMPARED WITH

VARIOUS INDEXES OF CITY SIZE

	St. Louis	San Francisco	Minneapolis
Population	857,000	784,000	522,000
Incorporated Land Area,* square miles	57.0	45.1	53.5
Population Density, persons/square mile	15,000	17,300	9,700
Maximum Temperature Difference (D_T) ^oF	17.5	20.0	18.0
Minimum $R/\triangle T$ ($mi/^oF$)	.14	.18	.14

* This area does not include any water areas such as lakes and rivers.

D. VERTICAL TEMPERATURE GRADIENTS

No measurements of vertical temperature gradients were made with wiresonde equipment because of the greater need at Minneapolis for the available equipment. Local wiresondes are scheduled for the next quarterly period.

The nearest radiosonde station is at Columbia, Missouri, about 115 miles to the west. There are no major topographic discontinuities between Columbia and St. Louis. Therefore, in the absence of frontal systems, the Columbia raob data should indicate reasonably well the degree of atmospheric stability over the open lands surrounding St. Louis. Thus for each of the four surveys reported here, Columbia raob soundings and winds-aloft data for the first 4000 feet above the surface are given for 2100 CST, corresponding to a selected isotherm chart, and for the preceding and following mornings at 0900 CST (Figs. A-1, A-5, A-8, and A-10).

A comparison of the four low-level vertical temperature gradients at Columbia with the four corresponding temperature differentials at St. Louis shows a close agreement between the strength of the inversion and the intensity of the St. Louis D_T (see Table IV-2). With strong inversions of 9.8° F per 400 feet, as in M-1016 (Fig. A-5), there is a maximum D_T of 17.5° F, but with a lapse of 0.8° F per 400 feet as in M-1020 (Fig. A-8), the intermediate values decrease on a nearly straight line relationship, reaching a minimum D_T condition of 4.2° F. More data are needed to establish a definite relationship. However, some evidence of such a relationship at Minneapolis and elsewhere supports the conclusion that this correlation between D_T and inversion intensity has possibilities of general application.

E. SELECTION OF SITE FOR AEROSOL CLOUD STUDIES

The criteria for selecting sites suitable for aerosol cloud studies employing the fluorescent tracer technique were discussed in JQR 2. It was noted that of the areas ranging from a quarter to a mile on a side, one area should be typical of the major built-up portion of the city, including commercial and residential structures, and that other areas enabling comparative studies should have relatively similar population densities and land use characteristics. Additional requirements of an appropriately selected test site are a minimum horizontal temperature gradient across it, reasonable level terrain, and a uniform building density also in the surrounding region.

Based on considerations of the foregoing criteria, mesometeorological survey results, personal inspection, and examination both of topographic maps and aerial photographs, a five square mile test area was selected. It is bounded by Grand Boulevard on the west, Palm Street on the north, Chouteau Avenue on the south, and Broadway and Third Streets on the east. Relatively flat, densely built up, and sparsely tree covered, this area includes the downtown district which will be used as one test and is large enough so that a number of one square mile test sites of intermediate building density can be selected.

V. AEROSOL TRACER TESTS IN MINNEAPOLIS

A. SCOPE OF OPERATIONS

The fluorescent tracer studies described here are part of a continuing program designed to provide the field experimental data necessary to estimate munitions requirements for the strategic use of chemical and biological agents against typical target cities. The principal factors affecting such munitions requirements, the climatological and topographical requisites of a test city, and the characteristics of a suitable simulant agent were described in JQR 1. Also presented in the report was a general description of the city test planning required to obtain information which is applicable to any agent and type of munition and is dependent of the munition distribution on the target.

From past field experience it has been found that selected urban areas should be about one-half mile on a side and that approximately ten grams of the tracer material should be released from a fixed point source over a period of approximately five minutes. Dispersal of such duration minimizes the effect of transient fluctuations in local meteorological conditions and yields more reproducible as well as representative dosage patterns.

Listed below are the specific objectives of the tests described in this report. These tests were conducted in Able area (see Section V-B "Test Site") and involved point-source releases and in some instances included sequential sampling.

1. To determine the reproducibility of street level dosage patterns in an essentially residential area under given meteorological conditions;

2. To determine whether the street level dosage pattern from a point source is affected by the source position, that is, when the generator is located at an intersection, at a point midway between intersections, at a point within a block, or on a roof top.

3. To determine the effect on dosage patterns of day and night meteorological conditions.

4. To obtain data on the penetration of the aerosol cloud into residences at various distances from the aerosol disperser, and to determine whether there is any residual background or lingering effect of the cloud within buildings.

B. TEST SITE

Able Area, tentatively selected by 31 December 1952 as a desirable area for conducting aerosol cloud studies employing the fluorescent tracer technique, was the site for the field tests described in the present report. Approximately one and a half miles south of the central business district, the area is bounded by 25th Street, 35th Street, 1st Avenue South, and Chicago Avenue. It is reasonable flat although the terrain slopes gently to a 20-foot depression in the center (Fig. V-1). Primarily a residential area, it consists predominantly of two story frame houses (Fig. V-3). The area is bisected by an east-west railroad which runs along an underpass cut below the level of all streets except the one street crossing the sink at the 48-foot elevation. Thus, all north-to-south oriented streets except 5th Avenue span the railroad by bridges which are somewhat arched; the west and east embankments are 20 and 18 feet, respectively, at the highest points.

Along the railroad artery a moderately sized industrial complex has grown (Fig. V-2). Only to the north, along 4th Avenue between 27th and 28th Streets, are the manufacturing buildings from four to nine stories high. These constitute Minneapolis-Honeywell Regulator Corporation. Along Lake Street to the south, a commercial center has developed consisting predominantly of one and two story buildings.

Clinton School (Fig. V-4) the two story brick elementary school at Clifton Avenue and 28th Street, was used for a roof top meteorological station, for a wiresonde site, and for penetration-study operations. It is fully described in a later section of this report.

C. EQUIPMENT AND PROCEDURES

1. Aerosol Generation

A continuous blower-type aerosol generator* is used in each test to disperse the tracer material NJZ 2266 as an aerosol. The generator components include a small hopper for the dry powdered pigment, a high speed centrifugal blower to generate the aerosol, a feed mechanism to provide a controlled rate of powder delivery from the hopper to the blower, and a battery powered supply and control box. Recent modifications of the feed mechanism** permit delivery of approximately 1 to 3½ grams per minute for a period of at least ten minutes and with an average deviation of less than 3.5% from the mean discharge rate. By weighing the removable plexiglass hopper before and after a test, the precise amount of material dispersed can be determined.

The aerosol generating unit, supported by a metal frame, is operated either from the rear of a truck (Figs. V-5 and V-6) or from a roof top (Fig. V-7). Exact locations of the disperser during the currently reported tests are found in the respective isodosage charts in Appendix B. The first dispersing position for a given test involving several releases is established at the last minute so that optimum coverage of the sampler array is achieved by the aerosol cloud. In later releases during the night the generator is relocated on a roof top or at another position

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* For description see SBMR 147-11 and 14, and SQR 1856-3.
** Full details will be found in SQR 1856-5.

within a block of the first, provided there is no substantial wind shift. Dispersal starting time is fixed not only by a predetermined schedule but by work received on the radio network from the Test Director.

Upon completion of a test the generating unit is isolated for separate housing and maintenance at a location remote from the field office. Full precautions are taken to avoid accidentally introducing contamination into the field office premises which would reduce the accuracy and reliability of particle counts.

2. Sampling

a. Deployment and Exposure of Samplers

Membrane filter samplers, described and illustrated in Section III, were used exclusively in the currently reported series of tests. Units were deployed at a predetermined set of positions which included car, ground, roof, and inside installations (Figs. V-8 through V-13).

The basic array or grid pattern may be modified up to 20 minutes prior to the aerosol release. The samplers are dispatched to the most favorable positions based on meteorological data obtained during the preceding hour. Should the wind shift after the initial release has been made, instructions are given either by direct contact or by radio to redistribute certain samplers. Should a preassigned location not be reached or become available, the sampler is placed as close as possible to that location and the exact location and method of exposure recorded.

Though there is no specific orientation of filter surfaces, they are generally faced downward in the event of rain, and to the street side of cars and away from the objects to which the holders are tied. To approximate a man's height, surface-sampling holders are normally placed at or about the five foot level (Fig. V-9).

b. Sampling Period

Samplers are started on or before a scheduled zero time and are turned off several times after the duration calculated to be required for passage of the aerosol cloud. Each operator is instructed to check his sampler or samplers periodically and to cap all holders not in use. For each successive release he inserts a new filter-loaded holder, taking care not to change the sampler position. Between releases there is a 20 to 30 minute off-sampling period during which time pumps are not in operation.

c. Sequential Sampling

To check the time of cloud passage and the adequacy of sampling time, two filters are sequentially exposed during a given release. At a prescheduled time at selected stations primarily inside buildings and at a few outside positions downwind of the aerosol source, the operators remove an already exposed holder and insert another holder into the connective coupling of the same pump. The change is made quickly so that the off-sampling period is limited to a few seconds.

d. Flow Rating

A flow rate through each exposed filter is necessary for calculation of the total dosage which is defined as the number of particles deposited on the entire filter divided by the average flow rate. This flow rate for a given filter-pump combination can be predicted only approximately.

In practice particularly since the pumps (described in Section III) are not equipped with regulating devices, the actual flow rate is not necessarily constant during the sampling period and differs among the individual pump units. It is also determined by variations in permeability among the filters. During a normal exposure not enough material is collected on the filter surface to change its permeability. The flow rate used in the total dosage calculations is the mean between measurements made at the beginning and the end of the sampling period. This is currently accomplished by the modified Alnor Velometer Jr. described in Section III (Fig. V-14).

Flow rating can be done conveniently within satisfactory limits of accuracy inside the laboratory rather than at the site of operations at outdoor temperatures.*

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* In Minneapolis a number of direct flow rate measurements were taken to determine the effect of the ambient air temperature or the temperature of the equipment on the capacity of the sampling pumps. These measurements were made in a room at 74° F and out-of-doors at 7°F. The flow rate was measured immediately after all equipment, including the flow meter, was transferred to the warm room from out-of-doors and yielded a high value of 8.7 liters per minute. On the other hand, a low value of 7.6 liters per minute was obtained when measurement was taken immediately upon removal of the equipment from the room to the outdoors. An extreme 14% change in flow rate was thus observed. Under a more normal or usual situation, however, the change was found to be in the range of 0.3 to 0.5 liters per minute, or an average of 5% higher out-of-doors.

A standard filter-loaded holder has been used recently to eliminate the need for flow rating of exposed filters after the release. Since this holder remains in the laboratory, its use as a standard, in preference to an exposed holder, lessens the possibility of cross contamination in the handling of filter units. Before a tracer test the filter-loaded holders belonging to the same sampling group, that is, those operated by the same pump, are flow rated; first, the holders that are to be exposed during the test, and next the holder considered as the standard. After the experiment flow rate measurement is taken of the standard holder only. The resulting relationship between the initial and final readings of the standard is used to extrapolate the expected flow rate change for the other holders.

Data gathered during the current period from test FT 0009 indicate that this extrapolation method of determining the final flow rates of the exposed filters is a valid procedure. These data provide a comparison between the extrapolated final flow rate and actual flow measurements made on a group of 95 exposed filters distributed among 30 pumps, each pump being tested with a filter used only as a standard.

The mean deviation between the extrapolated and the measured flow rates was found to be 3.3%, and 90 out of the 95 filters shown mean deviations of less than 10%. Two filters showing a 30% deviation, probably due to gross errors in the flow rating technique, were not included in the above figures, although they formed a part of the same group of samplers employed in an actual field experiment.

It should be noted that the foregoing figures reflect not only the expected validity of the extrapolation method, but also all of the additional errors entailed in the flow rate measurements. Moreover, if the flow rate used in calculating total dosages is taken to be the average of the initial and the extrapolated final flow rates, then the effect of the above deviations on the accuracy of the total dosages are even less, and still greater is the justification for dispensing with the procedure of actually measuring the final flow rates of the exposed filters.

3. Filter Analysis

The large number of samplers used in the aerosol hour tests and the fact that tests are run in rapid succession requires that the results be evaluated as quickly as possible in order to plan subsequent tests. Therefore, a comparison technique, briefly described below, has been established for obtaining a preliminary evaluation (preval) of the filter count. When plotted, the prevals provide a preliminary estimate of the test result within a few hours after the release is made. In the course of the preval operation, the filters are segregated according to estimated particle count after which they are mounted on microscope slides and counted for final evaluation.

Prevals are made after exposed holders have been flow rated and placed in racks, 24 at a time, but before the filters are removed from their holders for microscopic examination. Estimates are made of particle concentration by moving the racks alongside an array of standard filters containing previously determined counts of varying particle densities. The comparison between unknown and standard filters is made under 5X magnification. With this procedure the smallest detectable number of particles on the collection surface is approximately 500. When the number of particles is greater than 5,000, the filter count can be estimated to within a factor of two. Since all pumps operate at very nearly ten liters per minute, the preval is equal to the estimate count divided by ten liters per minute.

Filters showing positive prevals are removed from the rack as they are examined and grouped in four categories depending on the preval, as indicated below:

Group	Preval
I.	0 to 50
II.	50 to 40,000
III.	40,000 to 100,000
IV.	$>$ 100,000

The filters are kept in the above groups during further processing which includes mounting on glass slides, boxing, storing, and counting. The slides belonging to the first group are examined with a 3.4X Spencer objective and 10X eyepieces, and, if fewer than six particles are found, no further examination is required and the filter is classed as zero. For those slides containing six or more particles, the standard 16 mm objective is used and the filters are counted either by traverses or by fields. The standard counting techniques, the statistical considerations by which the minimum representative count of 270 was determined, and the respective formulas for estimating total particle counts are described in SQR 1856-4.

4. Meteorology

It was seen in JQR 2, and reiterated by the temperature surveys reported above in Section IV, that measurements of horizontal and vertical temperature gradients in urban and peripheral areas are prerequisite to a selection of proper sites for conducting aerosol tracer tests. So that correlations can subsequently be made with the dosage distribution data, complementary two-meter air temperature surveys are made including vertical temperature soundings. In addition, auxiliary meteorological observations must be made within the selected areas before and during the individual tracer tests. Two types of field meteorological stations are responsible for these observations: the surface leval and the roof top stations.

The first type consists of two to three automobiles, each equipped with

a. A sensitive microtorque wind vane mounted on the automobile top at approximately two meters (Fig. V-15);
b. An Esterline-Angus milliameter placed inside the car for continuous recording of street level wind direction (Fig. V-16); and
c. An Alnor Velometer for measuring wind velocities at ten minute intervals.

Measurements are taken while the cars are parked at predetermined locations: one approximately a half block (150 feet) upwind of the aerosol source, and another along the general axis of the aerosol cloud at the downwind edge of the test grid. One hour before the first release at Z time, the cars are parked generally on the downwind side of a street, not in the lee of a building but preferably on the downwind side of an intersection or facing an open area. During this one hour period, personnel prepare balloons and keep in constant communication with the Test Director for receiving or supplying pertinent information.

The roof of the Clinton School (Fig. V-17), 35 feet above street level, is similarly equipped with a wind vane which is set three feet higher on the parapet at the farthest upwind edge of the building. At ten minute intervals wind velocity is likewise measured with a hand held Alnor Velometer.

Various procedures are common to the auxiliary meteorological stations. At a specified time immediately prior to release time, toy balloons, inflated with helium and weighted to give a long low angle trajectory, are released at all points (Fig. V-18), and additional wind drift observations are thereby obtained. At ten minute intervals all dry bulb thermometers are checked as are the wet bulb thermometers when the occasion warrants. In addition pyrometers are used to obtain representative measurements of typical building, snow, and road surfaces in the general vicinity of the meteorological stations (Fig. V-19).

All measurements, including observations of cloud cover, gustiness, and precipitation, are taken during all releases. As noted above, trends or sudden changes are immediately reported by radio to the Test Director.

Should appreciable shifting of the aerosol disperser be required, the meteorological station in its proximity is relocated to a point upwind of the generator.

D. SUMMARY OF RESULTS

During the present quarterly period 24 tracer tests involving 61 releases of fluorescent particulate material were conducted in four selected areas. Of these tests six are fully evaluated in this report: FT's 0003, 0004, 0008, 0009, 0010, and 0011. Each test, comprising two to four point-source releases from vehicle or roof top position, was conducted in Able Area which earlier descriptions have identified as representative of the city with respect to meteorological and land use factors and which in all likelihood will be the standard by which other test areas and the results obtained in them will be considered.

Of the point-source releases summarized in Table V-1 in terms of aerosol source, meteorological, and area-dosage information, 11 were made at night, three in the afternoon, and four in the early morning hours. The early morning releases comprising FT 0010 are considered as nighttime operations since they were completed before dawn. In four tests, FT's 0008, 0009, 0010, and 0011, sampling units were placed both within and outside Clinton School. In some instances the samplers nominally considered outside were actually placed within the building with nozzles extending beyond the windows. House penetration studies were also made in FT's 0008, 0009, and 0011, and samplers were operated sequentially at selected residences.

For each test the applicable isodosage charts, area-dosage relationships, summary of house penetration and Clinton School results, isotherm map for an associated temperature survey, St. Cloud raob soundings, wiresonde graphs, and synoptic meteorological summary are presented in Appendix B. Evaluation of the associated temperature surveys in terms of D_T, $[R/\Delta T]_{min}$, and other quantitative values will be made in a later report.

TABLE V-1

SUMMARY OF FP POINT-SOURCE TESTS IN ABLE AREA

(AEROSOL CONDITIONS AND RESULTS*)

		AEROSOL SOURCE			TEST AREA METEOROLOGICAL CONDITIONS							TEST RESULTS (Area in Sq. Yds. Per Gram) Particles per minute per liter			
					Wind Flow Street Level		Wind Flow Roof Level								
Test No.	Date 1953	Time of Release CST.	Amount Released (grams)	Release Height	Vel. (MPH)	Dir.	Vel. (MPH)	Dir.	2 Meter Ambient Temp. °F	Sky Cover	Ground Cover	10,000	1,000	100	10
FT 0003a	19 Jan.	2032	7.7	Surface	2.2	NW	4.0	W	18	Low ovc.	Snow	640	1,400	6,700	
FT 0003b	19 Jan.	2135	6.9	Surface	1.2	NW	2.1	W	18	Low ovc.	Snow	1,200	2,800	9,100	19,000
FT 0004a	21 Jan.	2010	5.8	Surface	2.0	E	4.5	E	31	Med.ovc.	Snow			6,500	
FT 0004b	21 Jan.	2123	6.7	Surface	0.9	E	4.5	E	31	Med.ovc.	Snow			10,500	
FT 0004c	21 Jan.	2243	9.1	Surface	1.0	E	7.5	E	31	Med.brkn.	Snow		3,960		
FT 0008a	3 Feb.	2006	8.1	Surface	1.0	SSE	0.5	ESE	24	Clear	Snow	1,140	3,470		
FT 0008b	3 Feb.	2134	9.0	Surface	0.5	S	1.2	ESE	23	Clear	Snow	1,260	8,160	39,000E	
FT 0008c	3 Feb.	2304	7.4	Surface	0.5	S	1.9	SE	21	Clear	Snow	2,880	13,500	47,900	
FT 0009a	9 Feb.	2017	12.2	Surface	5.0	NE	-	E	27	Med.ovc.	Snow		400E	7,350	
FT 0009b	9 Feb.	2135	12.3	35 ft	5.0	NE	-	ENE	28	Low ovc.	Snow		380E	7,500	
FT 0009c	9 Feb.	2305	12.0	Surface	6.5	ENE	9.0	ENE	28	Low ovc.	Snow		974	6,160	
FT 0010a	12 Feb.	0020	13.3	30 ft	3.8	NW	6.0	NW	20	Clear	Snow		1,200	10,000	
FT 0010b	12 Feb.	0140	12.1	Surface	4.0	NW	8.0	WNW	18	Clear	Snow		560	8,500	
FT 0010c	12 Feb.	0305	11.5	Surface	3.0	WNW	4.5	WNW	18	Med. sctd.	Snow		1,700	12,000	
FT 0010d	12 Feb.	0425	12.2	Surface	3.2	NW	2.0	NNW	20	Low ovc.	Snow		390	12,000	
FT 0011a	15 Feb.	1405	11.8	35 ft	3.7	WNW	5.0	W	7	High sctd.	Snow		400E	3,900	23,000
FT 0011b	15 Feb.	1535	11.6	35 ft	3.9	NNW	5.0	WNW	6	High sctd.	Snow		230	2,100	43,000
FT 0011c	15 Feb.	1710	10.9	Surface	3.0	NNW	4.0	NW	3	High sctd.	Snow		970	7,300	25,000

* All tests comprised point-source releases over a period of 5 minutes.

E. PRELIMINARY COMMENTS ON AEROSOL CLOUD BEHAVIOR

1. Dosage Areas

The six tests in Able Area involving eighteen releases were conducted under wind conditions which ranged from an average of 0.7 mph for one test night to 5.5 mph on another night. Vertical temperature gradients ranged from 1.5° F lapse to 2.5° F inversion in 200 feet.

The areas within given dosage isopleths, when adjusted for the amount of material released, were at a maximum on the night with inversion conditions existing. They were at a minimum for the daytime test. Based on an average of all releases during a given test, the areas within the 1000, 500, and 100 isodosage contours were greater under inversion conditions (FT 0008) by factors of 14, 8, and 11, respectively, than for daytime lapse conditions (FT 0011). If the areas are further adjusted for wind speed, the factors become 2 1/2 and 1 1/2.

For each test a presentation of dosage values versus enclosed areas in square yards is shown in Appendix B (Figs. B-4, B-10, B-17, B-24, B-31, and B-39). The averages for each series of releases on a single night or afternoon are shown in Fig. V-20. In all cases these are corrected for wind speed and amount released $\left(\frac{\text{CtA x mph}}{\text{grams}}\right)$.

Figure V-21 shows the CtA relationships for averages of the three daytime Minneapolis releases (FT 0011) and of ten daytime releases in England at Salisbury.*

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* C. J. M. Aanensen, Diffusion of Smoke in a Built-up Area, Porton Technical Paper No. 193, 1950.

These are based on areas per gram of material released and are not corrected for wind since in Minneapolis the wind was measured in the test area, but in Salisbury it was measured in an open area outside the test area. If adjustments for wind were made, the difference between the two would probably be greater than shown.

2. Cross Wind Integrated Dosages (CWID)

Maximum adjusted cross wind integrated dosages were obtained on FT's 0008, 0009, and 0010. In general CWID values for these tests were about four times greater than for FT's 0003, 0004, and 0011. FT 0008 was run under ground inversion conditions; FT's 0009 and 0010 were run under slight inversions or 30 to 40 foot isothermal layers with bases at or below 50 feet (Figs. B-16, B-23, B-30).

Two of the three tests which showed low CWID values were performed at night with lapse conditions existing to at least 160 feet. The other was a daytime test with lapse conditions prevailing.

Figure V-22 shows the average CWID distance relationship for each series of releases with the CWID's adjusted for wind speed and amount released $\left(\frac{\text{CWID x mph}}{\text{grams}}\right)$.

3. Reproducibility of Dosage Patterns

When wind conditions were relatively constant throughout the succession of releases of a given test period, similar dosage patterns were obtained on all releases. Even when slight wind shifts moved the axis of the dosage pattern, the resulting change was primarily a change in orientation; the width and length of the pattern remained essentially the same.

The calculation of dosage patterns obtained from multiple source releases, based only on single source releases, can be reasonably accurate only if the variations of the single source dosage patterns with horizontal and vertical displacements of the source are considered. In these Minneapolis tests displacement of the source horizontally or vertically on successive releases caused no observable significant effect. However, since none of the four roof top releases were made under strong inversion conditions, it cannot yet be concluded that under all conditions those elements of a cluster which function on roofs will contribute to the total dosage at ground level to the same extent as those which function on the ground.

4. Variation of Dosages with Height

Vertical samples taken outside windows of the first and second floors of the Clinton School, with other samples being taken on the roof, indicate a slight drop-off of dosage with altitude. A total of 48 samples were taken during 12 releases. Expressed as per cents of the dosages obtained at a sampler on the ground nearby, the median values for the first floor, second floor, and roof as shown in Table V-2 were 93%, 88%, and 61.5%, respectively.

TABLE V-2

CLINTON SCHOOL VERTICAL ATTENUATION DATA

EXPRESSED IN PERCENTAGES OF GROUND LEVEL DOSAGES

	No. of Releases	No. of Samples	No. of Values Trace or Zero	Max (%)	Min (%)	Median (%)
First Floor	8	11	0	158	33	93
Second Floor	12	13	0	172	35	88
Roof	12	24	1	272	0	61.5
GROSS	12	48	1	272	0	81.5

5. Penetration

Penetration into the interior of the Clinton School showed somewhat lower values. For 71 dosages obtained during the same 12 releases, the median values for the ground floor, first floor, and second floor were 23.5%, 27%, and 22.5%, respectively. The ventilating system of the school was not in operation during the tests.

Penetration into houses differed markedly from that at the school. Based on only 42 dosages obtained during seven releases, the medians for basement, first floor, and second floor were 13%, 11%, and 2%. Until further data are obtained it is difficult to account for the low value on the second floor. A summary of penetration values at Clinton School and at several residences are given in Table V-3.

TABLE V-3

PENETRATION DATA EXPRESSED IN PERCENTAGES OF OUTSIDE DOSAGES

Houses	No. of Releases	No. of Samples	No. of Values Trace or Zero	Max (%)	Min (%)	Median (%)
Basement	7	19	7	58	0	13
First Floor	7	13	4	200	0	11
Second Floor	7	10	4	41	0	2
GROSS	7	42	15	200	0	11.5
Clinton School						
Ground Floor	12	36	4	100	0	23.5
First Floor	9	13	0	43	11	27
Second Floor	12	22	2	100	0	22.5
GROSS	12	71	6	100	0	23

Five houses in which penetration studies were conducted are described and illustrated in Figs. V-23 through V-27. With each of these figures is given a summary of the dosages obtained at or within the particular residence. No positive counts were obtained from outdoor and indoor samplers at a sixth house, F, located at 2722 Portland Avenue. The sampler arrays at Clinton School for FT's 0008, 0009, 0010, and 0011 are shown in Figs. V-28 through V-31, respectively. Each figure includes dosage summaries for all releases of the given test.

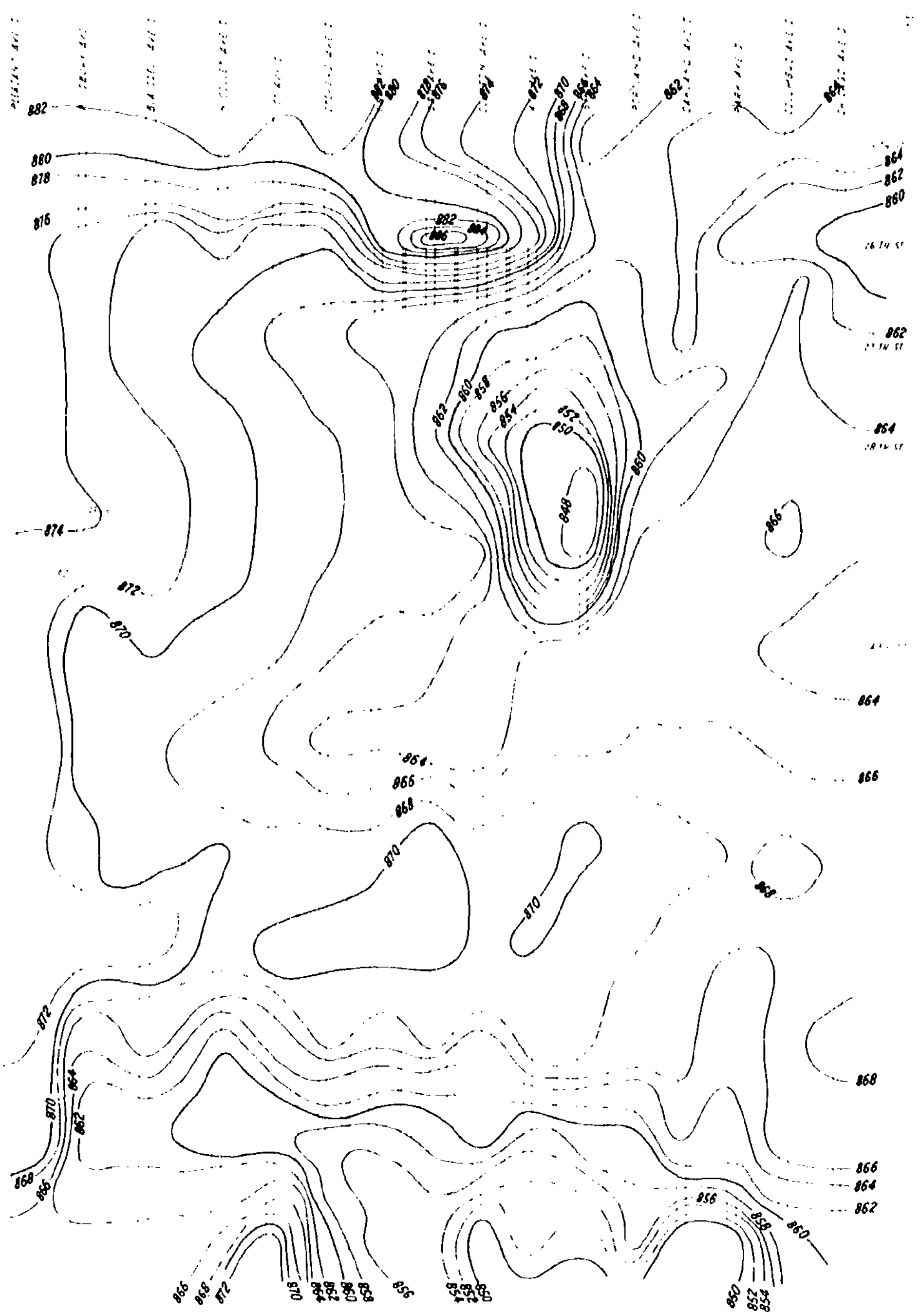

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FIG. V-I

TOPOGRAPHIC MAP
MINNEAPOLIS ABLE AREA

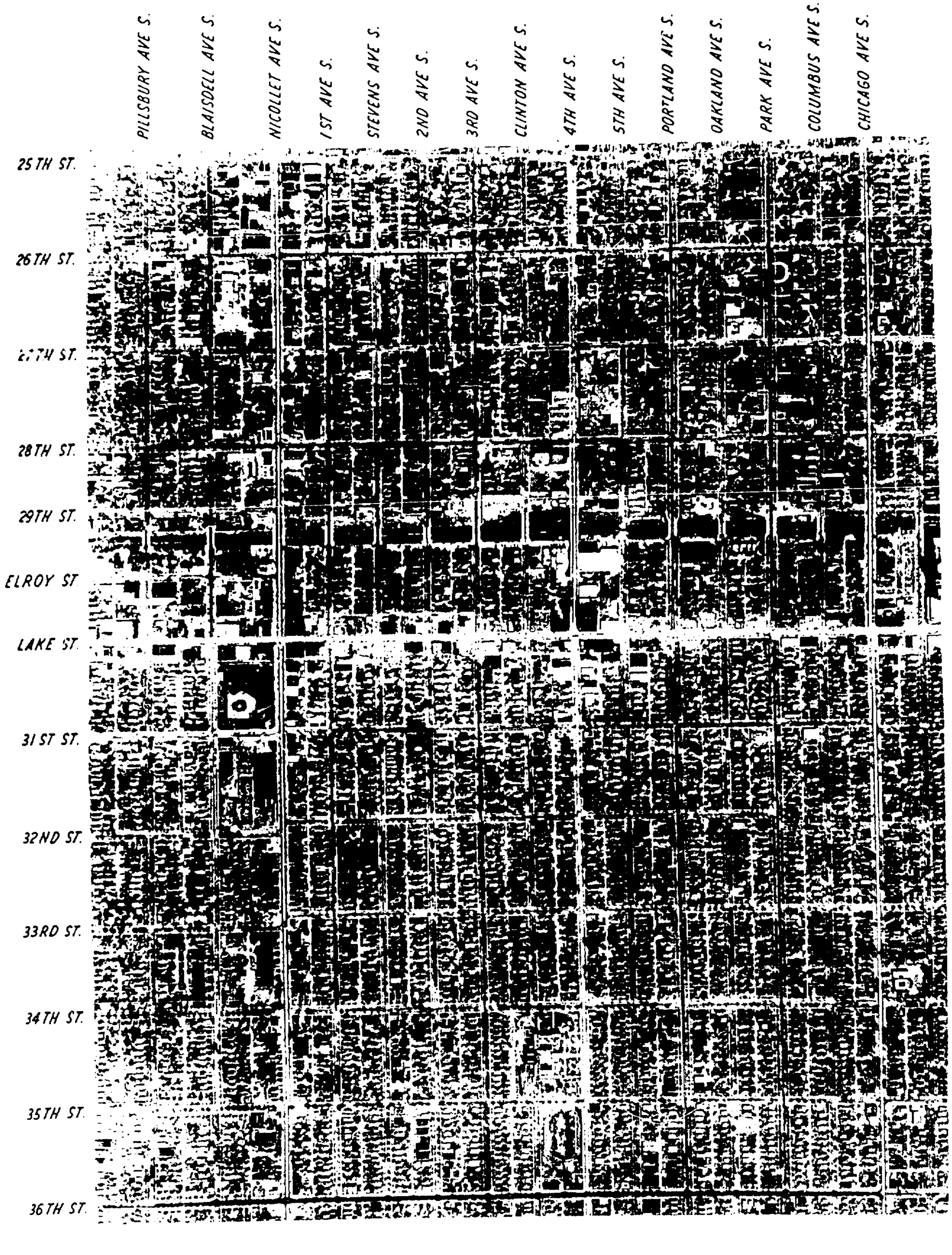


FIG. V-2 MINNEAPOLIS ABLE AREA

Fig. V-3

Typical Two Story Frame
Residences in Able Area.

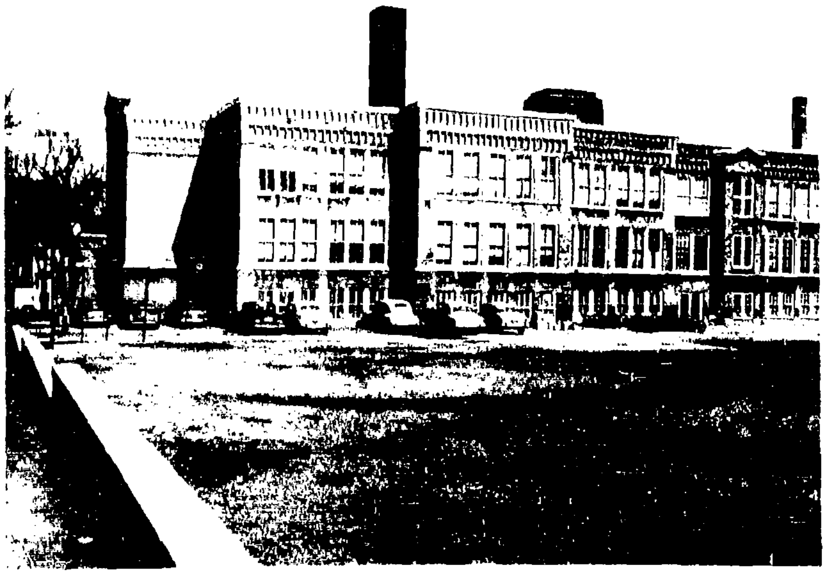


Fig. V-4

Clinton Avenue School viewed
from the southwest quarter.

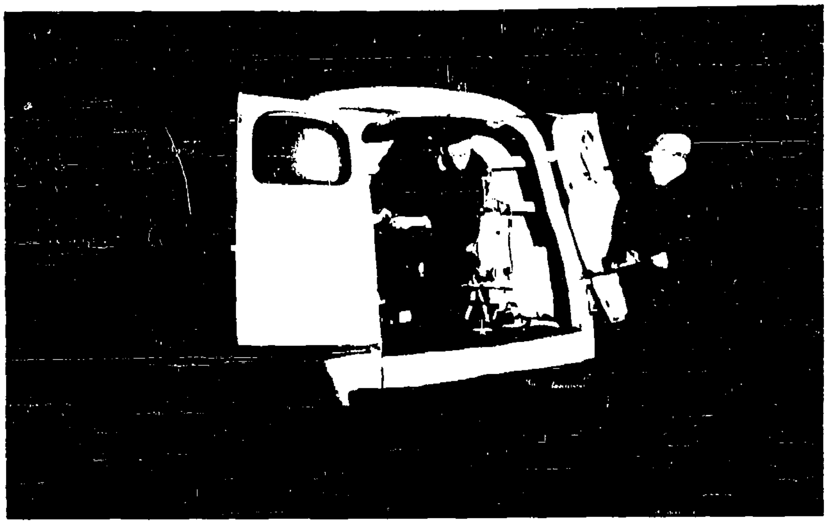


Fig. V-5

Aerosol Dispersal Crew checking equipment prior to a field test. Aerosol is generated from truck as shown.

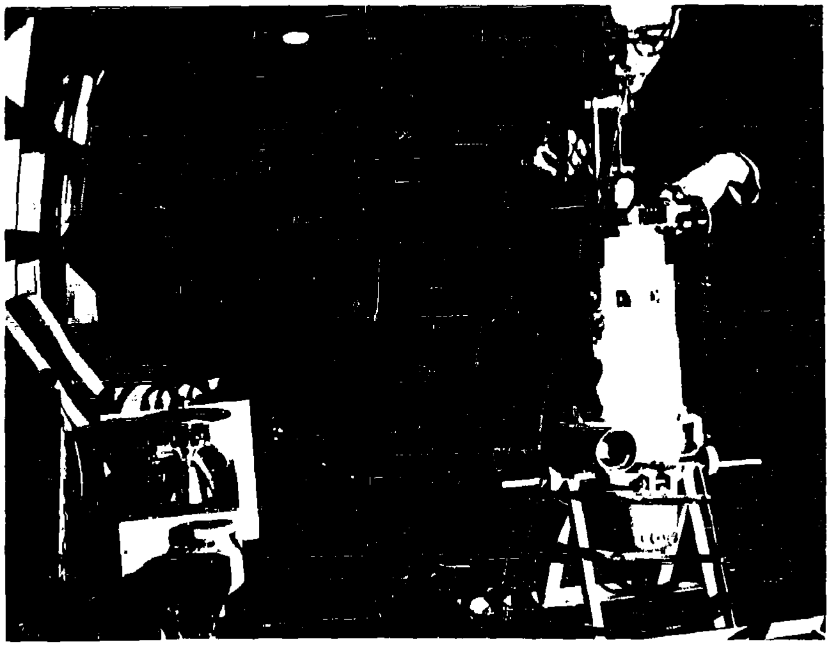


Fig. V-6

Aerosol Dispersal Equipment in truck as arranged for field test. Blower-generator is on right, beam scale for weighing tracer material is on box at left, with control box in background.

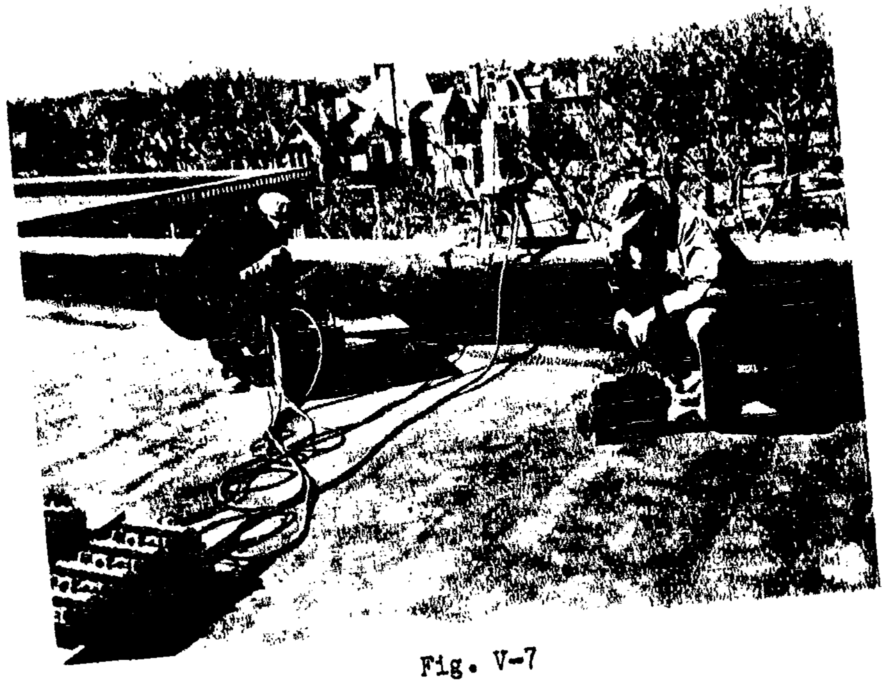


Fig. V-7

Typical roof top location
of aerosol disperser.

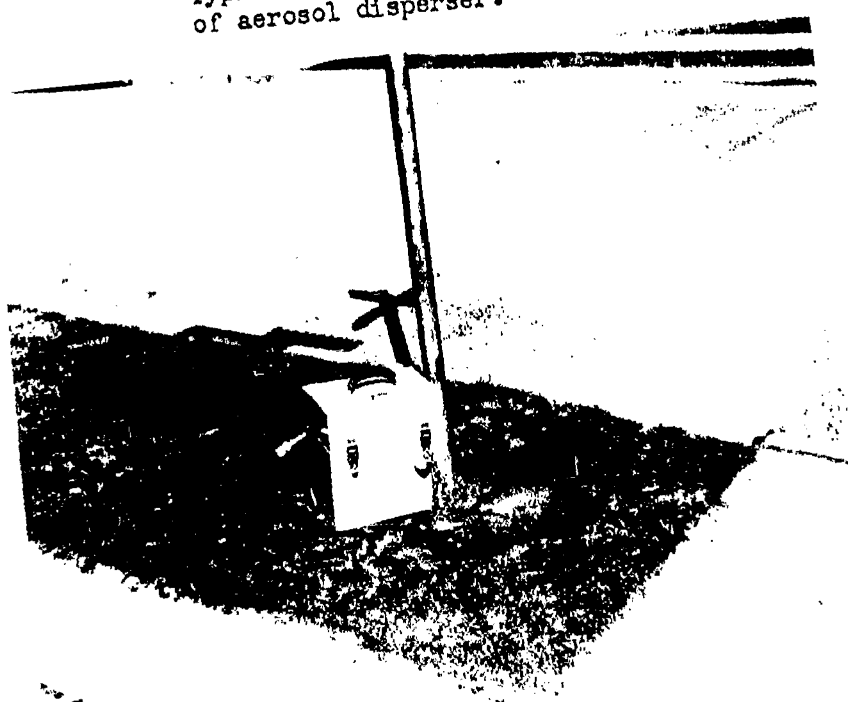


Fig. V-8

Sampler chained to post, with
filter at box level.

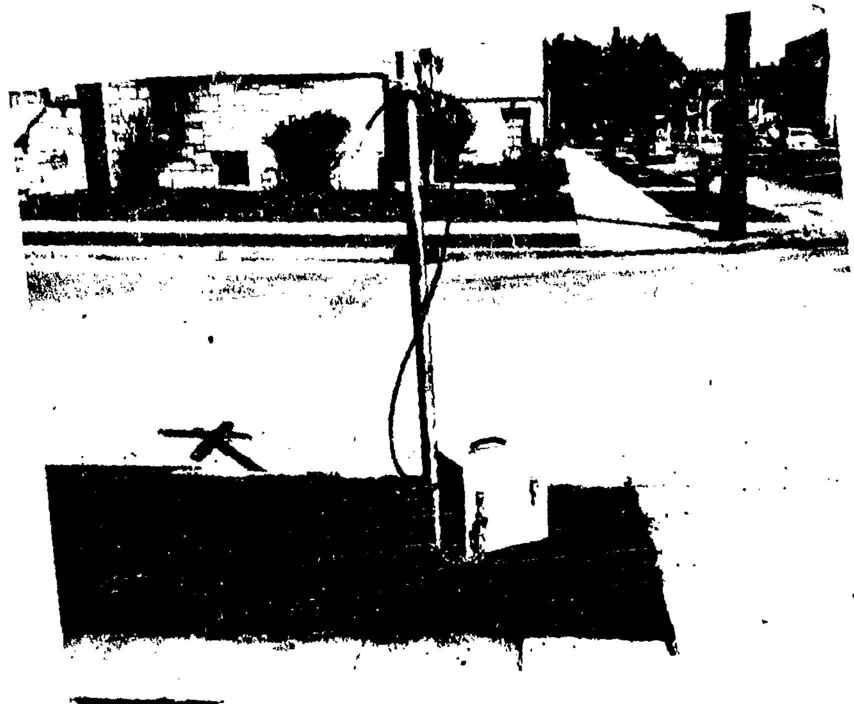


Fig. V-9

Sampler chained to post, with filter five feet above ground.

Fig. V-10

Typical arrangement of sampler location in car, with filter out window at five feet above ground.

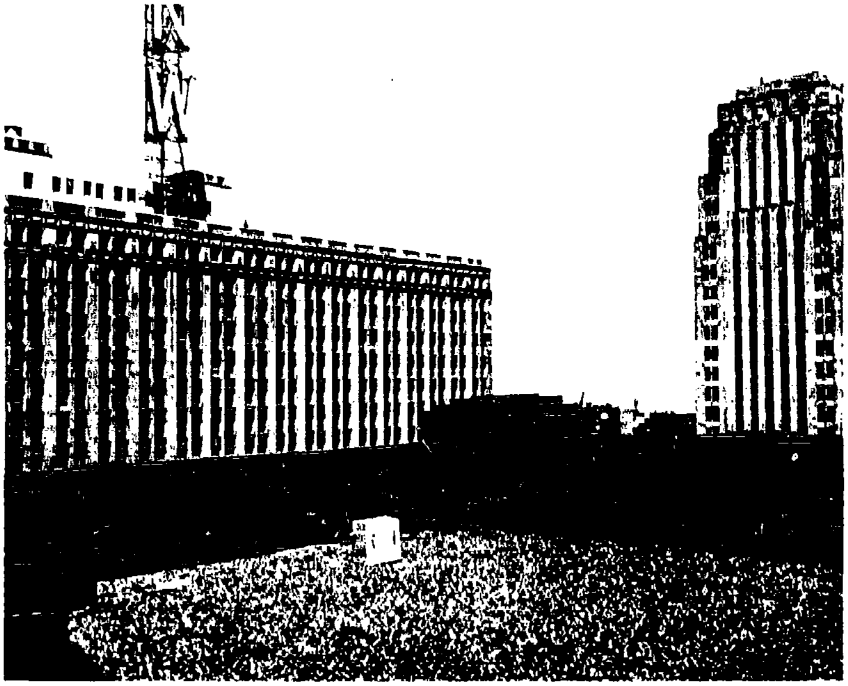


Fig. V-11

Typical roof top sampler location.

Fig. V-12

Sampler installation inside private residence.

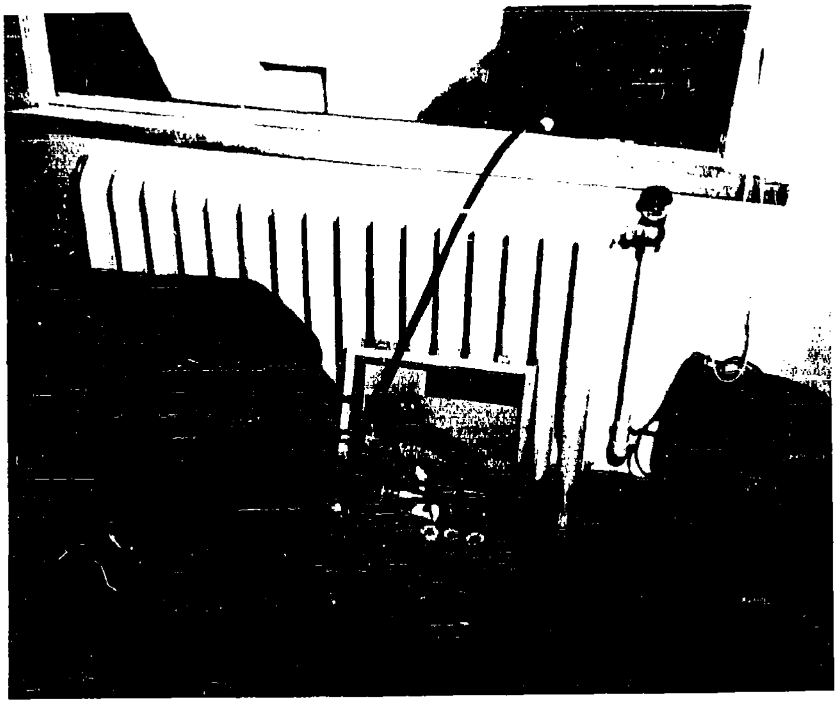


Fig. V-13

Typical indoor Sampler installation with filter exposed outside.

Fig. V-14

Method of obtaining flow rate of a filter.

Fig. V-15

Wind Direction Unit mounted on field meteorological station automobile.

Fig. V-16

Wind Direction Recording Equipment, showing Esterline-Angus recorder in meteorological station automobile.

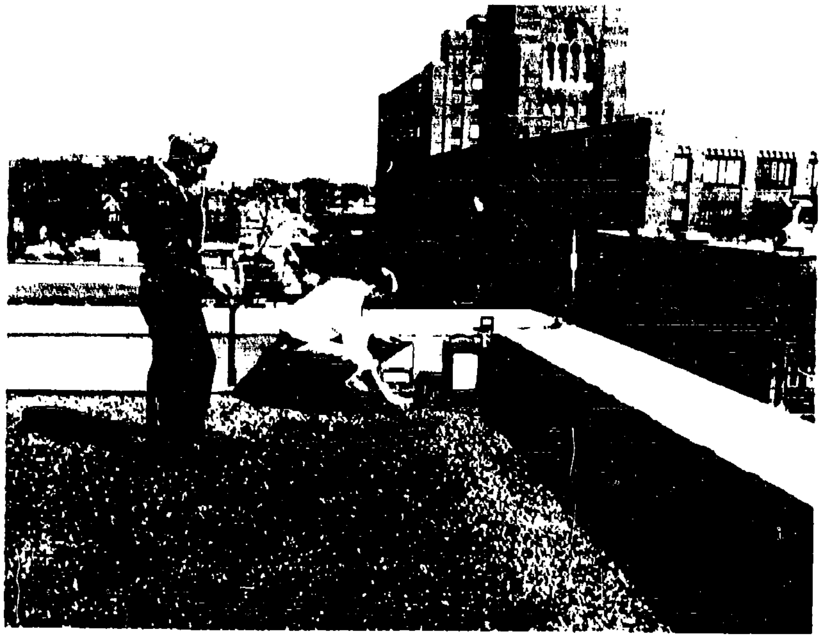


Fig. V-17

Meteorological Station on roof of Clinton School.

Fig. V-18

Field Meteorological Team reporting wind velocity and balloon track by radio.

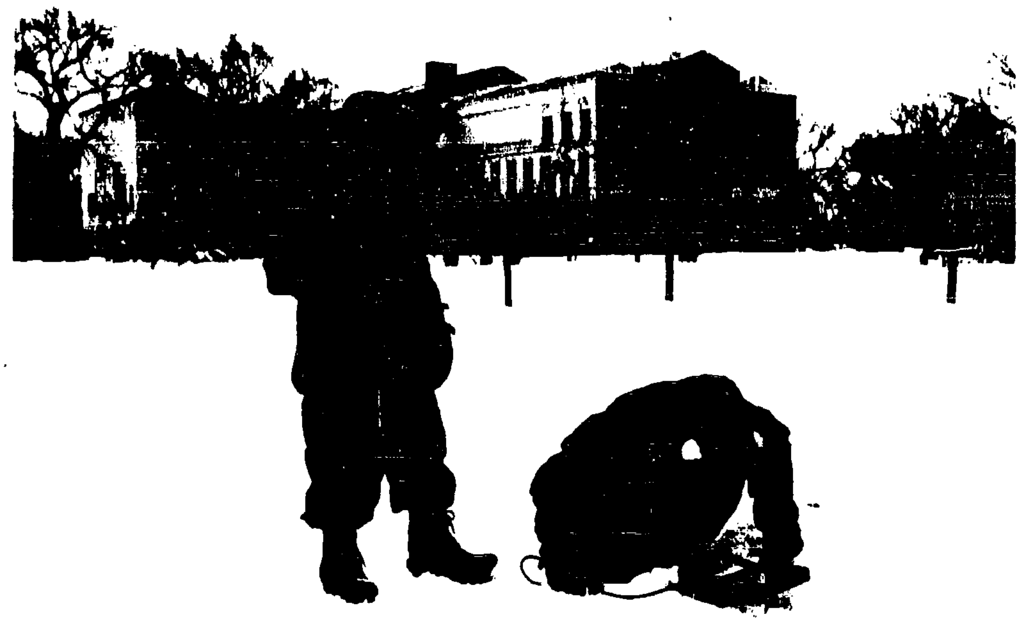


Fig. V-19

Field Meteorological Team taking air and surface temperatures.

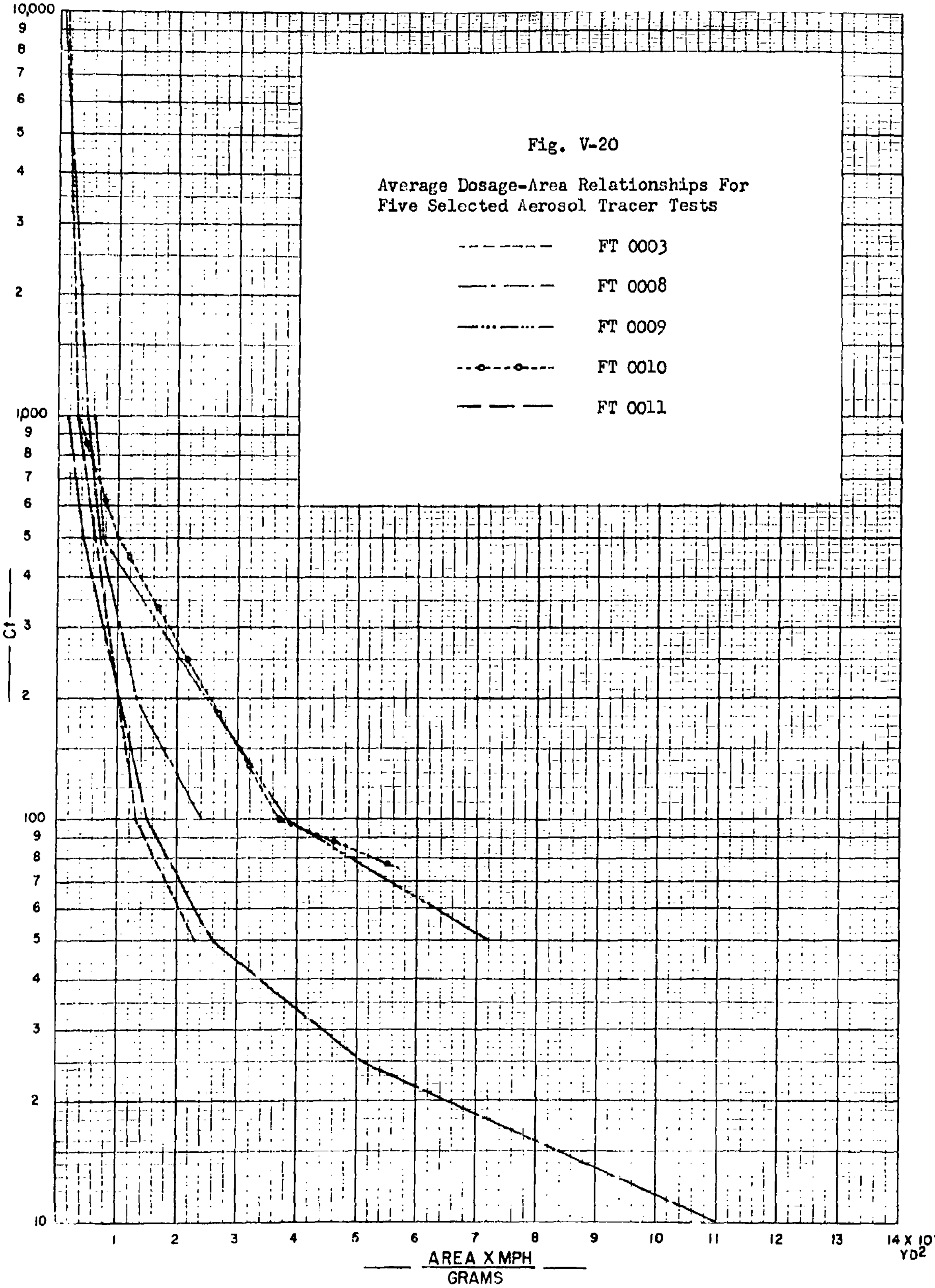


Fig. V-20
Average Dosage-Area Relationships For Five Selected Aerosol Tracer Tests
FT 0003
FT 0008
FT 0009
FT 0010
FT 0011
10,000
1,000
100
10
Ct
1 2 3 4 5 6 7 8 9 10 11 12 13 14 X 10^4 YD^2
AREA X MPH / GRAMS

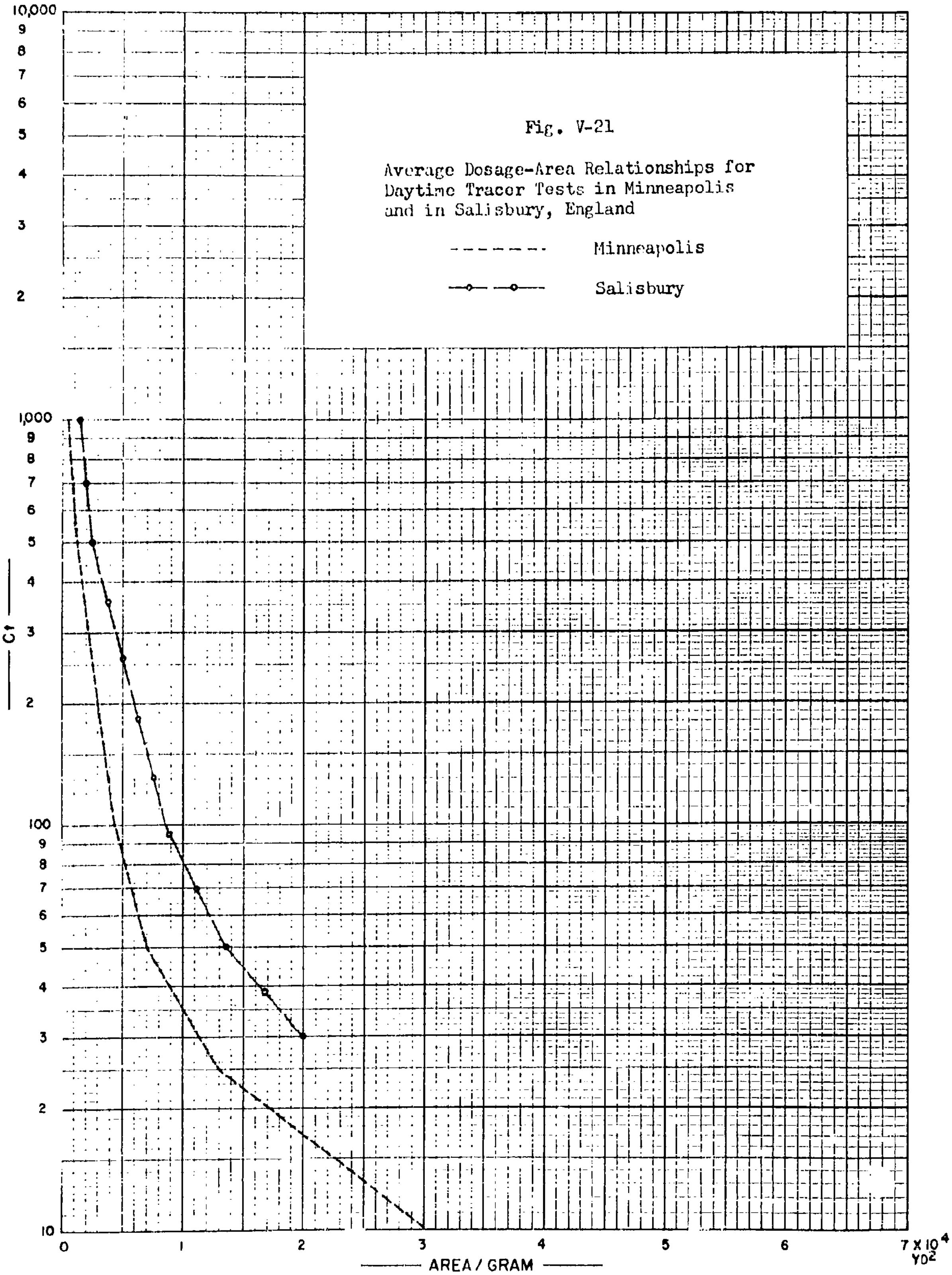


Fig. V-21

Average Dosage-Area Relationships for Daytime Tracer Tests in Minneapolis and in Salisbury, England

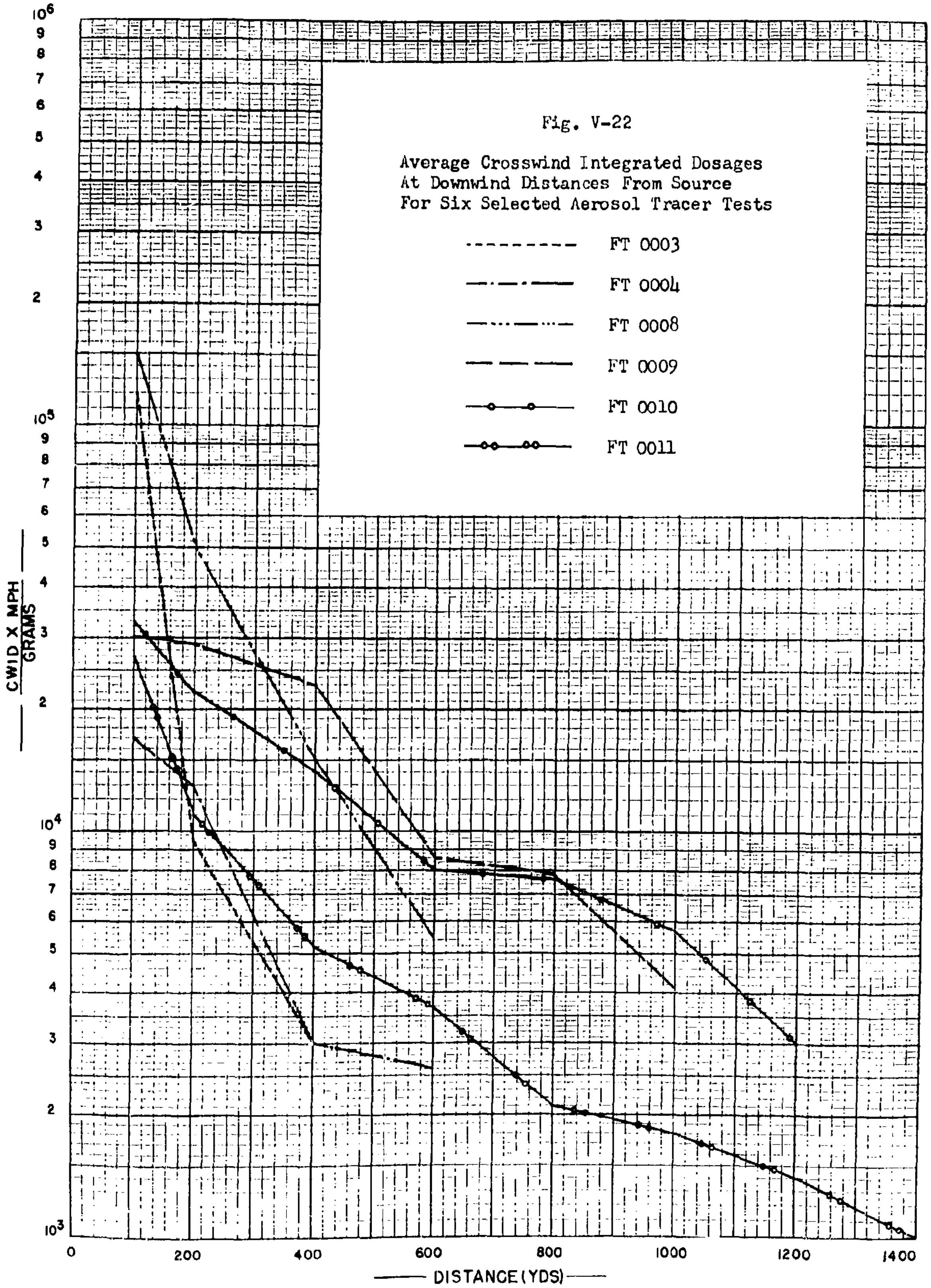


Fig. V-22
Average Crosswind Integrated Dosages
At Downwind Distances From Source
For Six Selected Aerosol Tracer Tests
FT 0003
FT 0004
FT 0008
FT 0009
FT 0010
FT 0011
CWID X MPH / GRAMS
DISTANCE (YDS)
0
200
400
600
800
1000
1200
1400
10^3
10^4
10^5
10^6

Fig. V-23

HOUSE A

a. Front View

b. Rear View

House A, at 2814 Third Avenue South, is a two story wooden frame structure, equipped with storm windows of the wooden frame type. It has no basement and is insulated only in the attic. On each floor are gas-space heaters which lack fans for circulating heat.

Dosages Obtained in House A*

Release**	Outside		Basement		First Floor		Second Floor	
FT 0008a	15	8	0	T	T	0	0	0
FT 0008b	26	152			3	17	0	3

*Dosages are expressed in particle-minutes per liter; T represents trace dosage, i.e., a count not exceeding 15 fluorescent particles. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units.

**Releases are listed only when positive counts were obtained outside. For the indicated releases, Figs. B-18 and B-19, Appendix B, show the house in relation to the grid complex and the dosage pattern.

Fig. V-24

HOUSE B

House B (not illustrated), at 2739 Second Avenue South, is a two story stucco building, equipped with storm windows of the wooden frame type. Its walls and attic are completely insulated. A gas-fired, hot-water boiler is located in the one-quarter basement.

Dosages Obtained in House B*

Release**	Outside		Basement		First Floor		Second Floor	
FT 0008a	0	3	0	T	0	T	0	0
FT 0008b	17	110	3	31	3	5	0	3
FT 0009b	4	0	T T	0 0	T	0	0	0

*Dosages are expressed in particle-minutes per liter; T represents trace dosage, i.e., a count not exceeding 15 fluorescent particles. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units. When more than one sampler is involved, values are listed on separate lines.

**Releases are listed only when positive counts were obtained outside. For the indicated releases, Figs. B-18, B-19, and B-26, Appendix B, show the house in relation to the grid complex and the dosage pattern.

Fig. V-25

HOUSE C

a. Oblique View

b. Sampler 15 feet from east wall of basement, with holder at box level.

House C, at 3021 Third Avenue South, is a completely insulated two story stucco building, equipped with storm windows of the aluminum type in the rear, and of the wooden frame type on the sides and front. A gas-fired, hot-water boiler is located in the basement.

Dosages Obtained in House C*

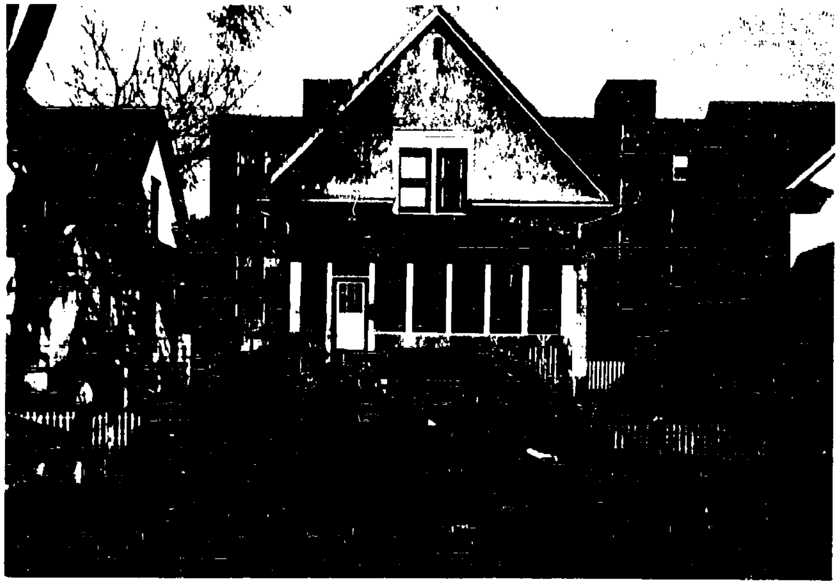
Release**	Outside		Basement		First Floor		Second Floor	
FT 0008b	4410	390	1000	493	141	160	83	117

*Dosages are expressed in particle-minutes per liter. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units.

**Releases are listed only when positive counts were obtained outside. For the indicated release, Fig. B-19, Appendix B, shows the house in relation to the grid complex and the dosage pattern.

Fig. V-26

HOUSE D



House D, at 2813 Fifth Avenue South, is a two story stucco frame structure, equipped with storm windows of the wooden frame type. Its upper story and attic are completely insulated. A gas-fired, hot-water boiler is located in the basement.

Dosages Obtained in House D*

Release**	Outside		Basement		First Floor		Second Floor
FT 0009a	79	0	12	2	13	9	
			5	5			
FT 0009b	395	T	31	10	52	13	
			39	8			

*Dosages are expressed in particle-minutes per liter; T represents trace dosage, i.e., a count not exceeding 15 fluorescent particles. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units. When more than one sampler is involved, values are listed on separate lines.

**Releases are listed only when positive counts were obtained outside. For the indicated releases, Figs. B-25 and B-26, Appendix B, show the house in relation to the grid complex and the dosage pattern.

Fig. V-27

HOUSE E

a. Oblique View

b. Rear View

House E, at 2625 Stevens Avenue South, is a two story wooden frame structure, equipped with storm windows of the wooden frame type. Its walls and attic are completely insulated. The first floor is heated by a coal furnace located in the three-quarter basement; the heating system is of the hot-air gravity type. The second floor is heated by an oil-space heater located in the living room.

Dosages Obtained in House E*

Release**	Outside	Basement		First Floor		Second Floor	
FT 0011a	643	341	30	302	18	218	27
		284	12				
FT 0011b	1040	475	11	708	32	409	36
		506	14				
FT 0011c	1970	996	25	1060	54	750	63
		851	48				

*Dosages are expressed in particle-minutes per liter. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units. When more than one sampler is involved, values are listed on separate lines.

**Releases are listed only when positive counts were obtained outside. For the indicated releases, Figs. B-40, B-41, and B-42, Appendix B, show the house in relation to the grid complex and the dosage pattern.

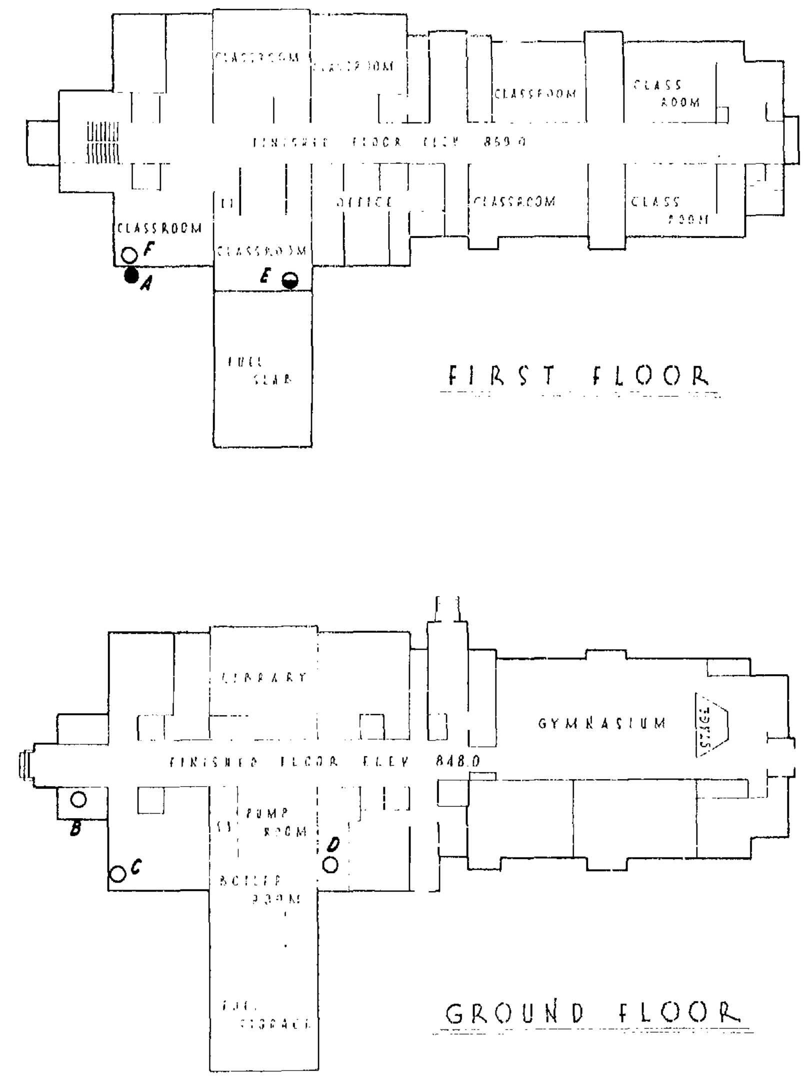
CLINTON SCHOOL DOSAGES*

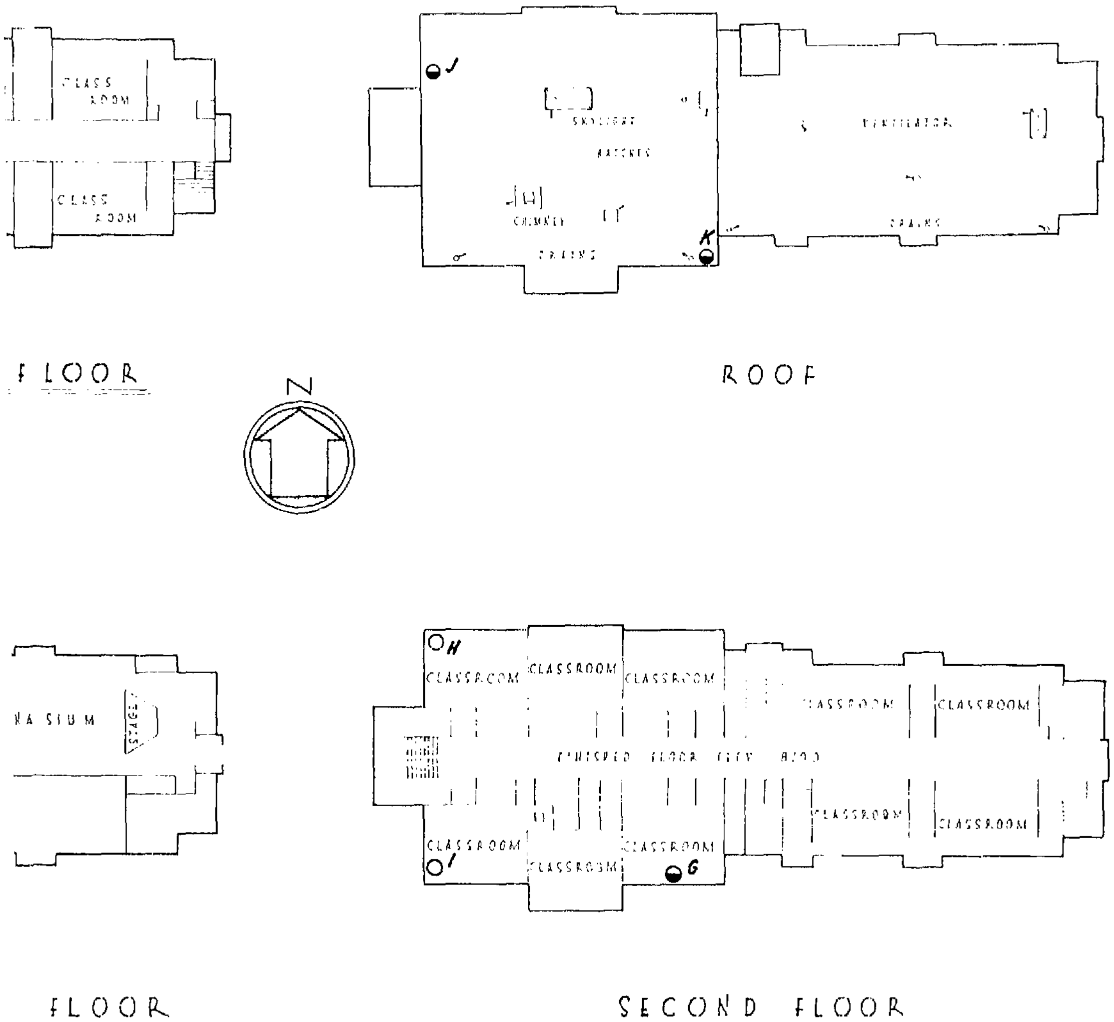
Sampler	Test Number: FT 0008a		FT 0008b		FT 0008c	
A	T	T	50	104	110	7
B	0		T		33	
C	0		0		35	
D	0	T	0	33	15	3
E	0	T	22	89	51	T
F	0	0	3	14	19	12
G	0	0	14	40	50	T
H	0	0	0	8	16	8
I	0		16		43	
J	0	0	27	50	50	T
K	0		33		59	

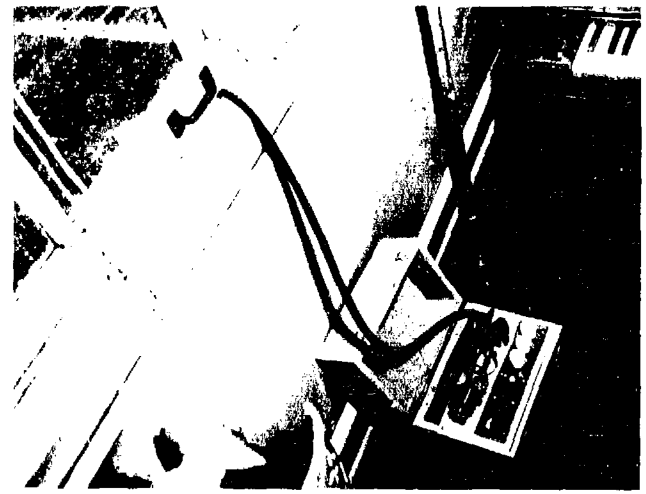
*Dosages are expressed in particle-minutes per liter; T represents trace dosage, i.e., a count not exceeding 15 fluorescent particles. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units. Sampling periods for a given release are listed in the respective isodosage charts appearing in Appendix B.

LEGEND

- ● Outside sampler on ground
- ◓ Outside sampler on roof or with filter holder out of window
- ○ Inside sampler







TYPICAL SAMPLER IN CLASSROOM WITH FILTER HOLDER OUT OF WINDOW

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FIGURE V-28
CLINTON SCHOOL SAMPLER ARRAY AND RESULTS
FT 0008
3 FEBRUARY 1953

2

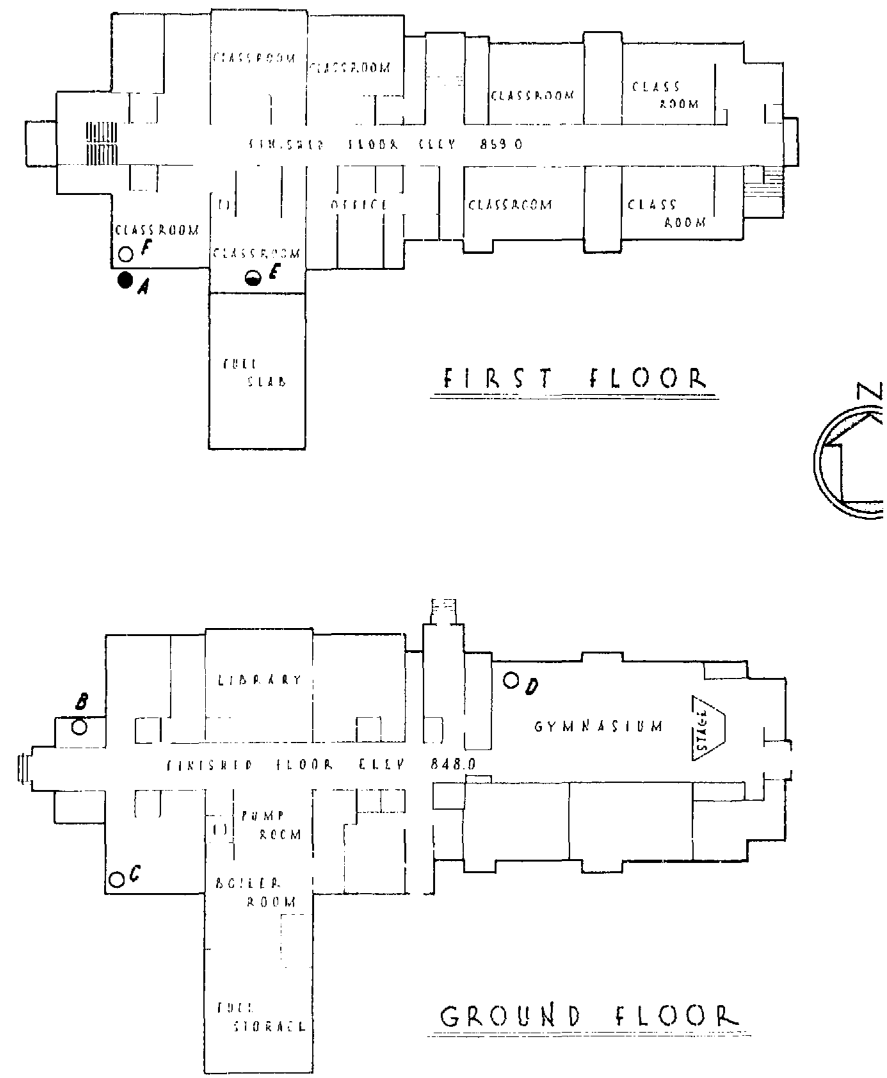
CLINTON SCHOOL DOSAGES*

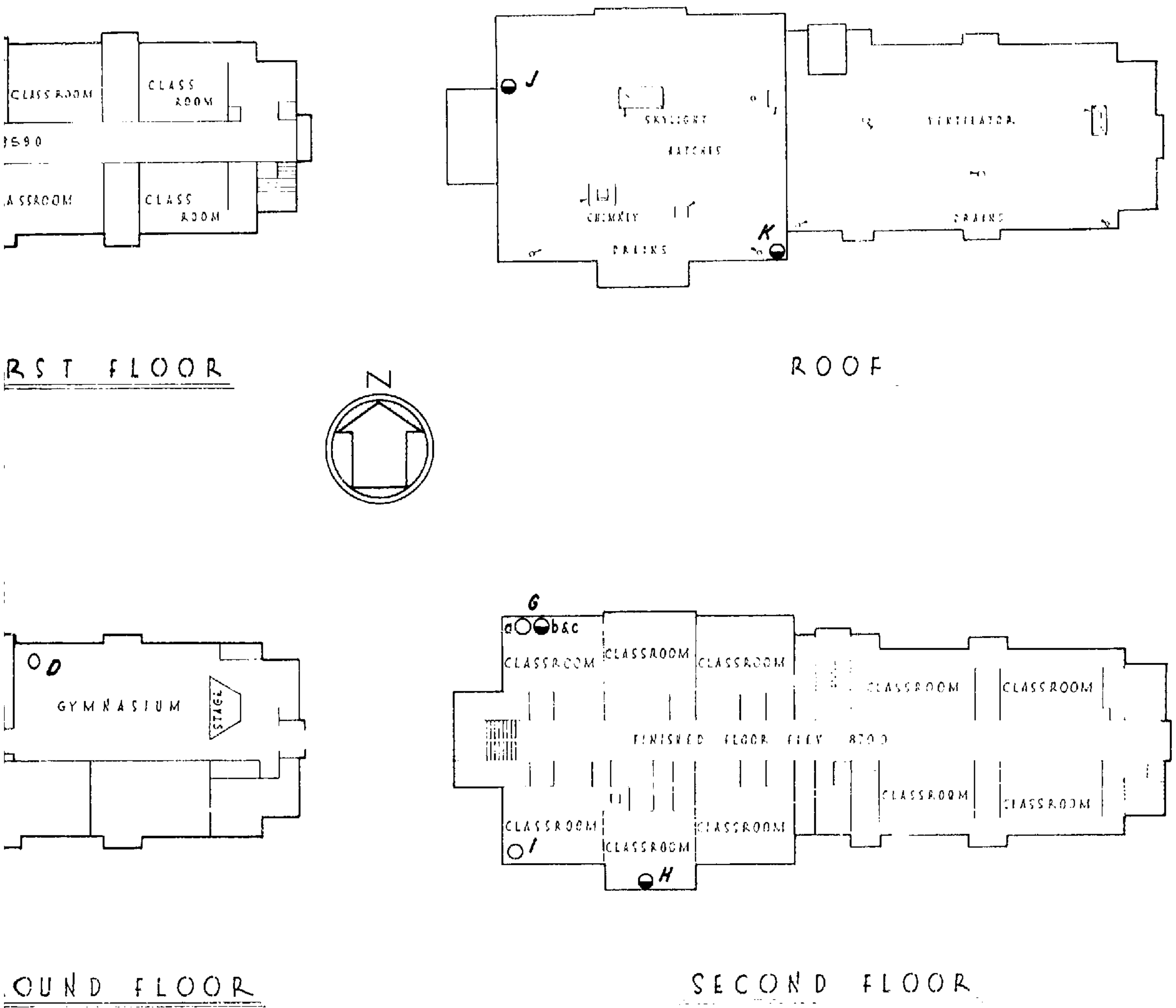
Sampler	Test Number					
	FT 0009a		FT 0009b		FT 0009c	
A	11	0	136	2	117	0
B	0	0	4	2	6	6
C	0	T	16	6	34	12
D	0	2	13	9	35	26
E	9	0	128	0	136	T
F	2	T	24	5	25	7
G	0	0	60	0	202	0
H	11	0	143	0	132	0
I	T	0	13	7	29	13
J	2	0	112	0	191	0
K	4	0	135	0	318	0

*Dosages are expressed in particle-minutes per liter; T represents trace dosage, i.e., a count not exceeding 15 fluorescent particles. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units. Sampling periods for a given release are listed in the respective isodosage charts appearing in Appendix B.

LEGEND

- ● Outside sampler on ground
- ◒ Outside sampler on roof or with filter holder out of window
- ○ Inside sampler





TYPICAL SAMPLER IN CLASSROOM WITH FILTER HOLDER AT BOX LEVEL

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FIGURE V-29
CLINTON SCHOOL SAMPLER ARRAY AND RESULTS
FT 0009
7 FEBRUARY 1953

2

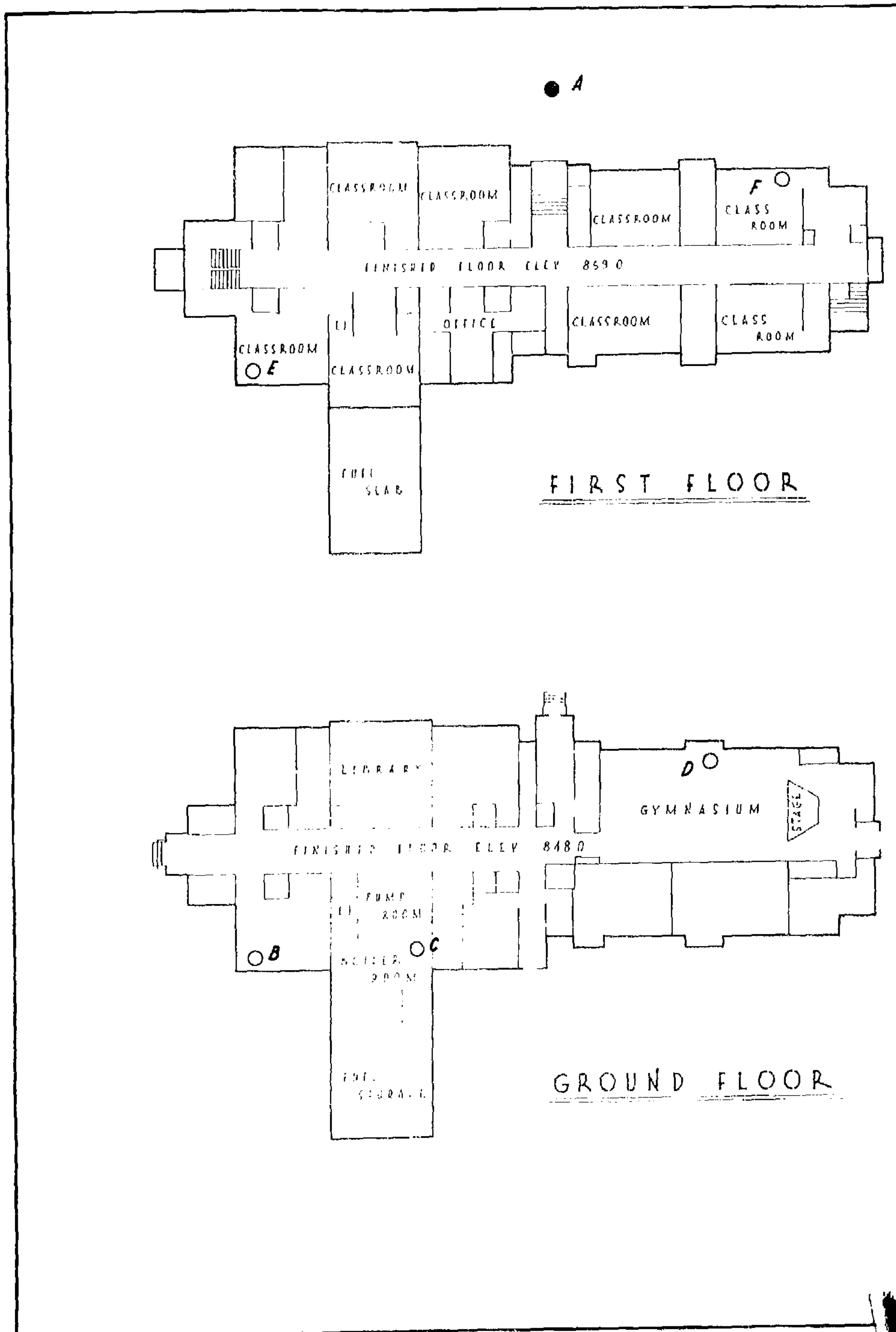
CLINTON SCHOOL DOSAGES*

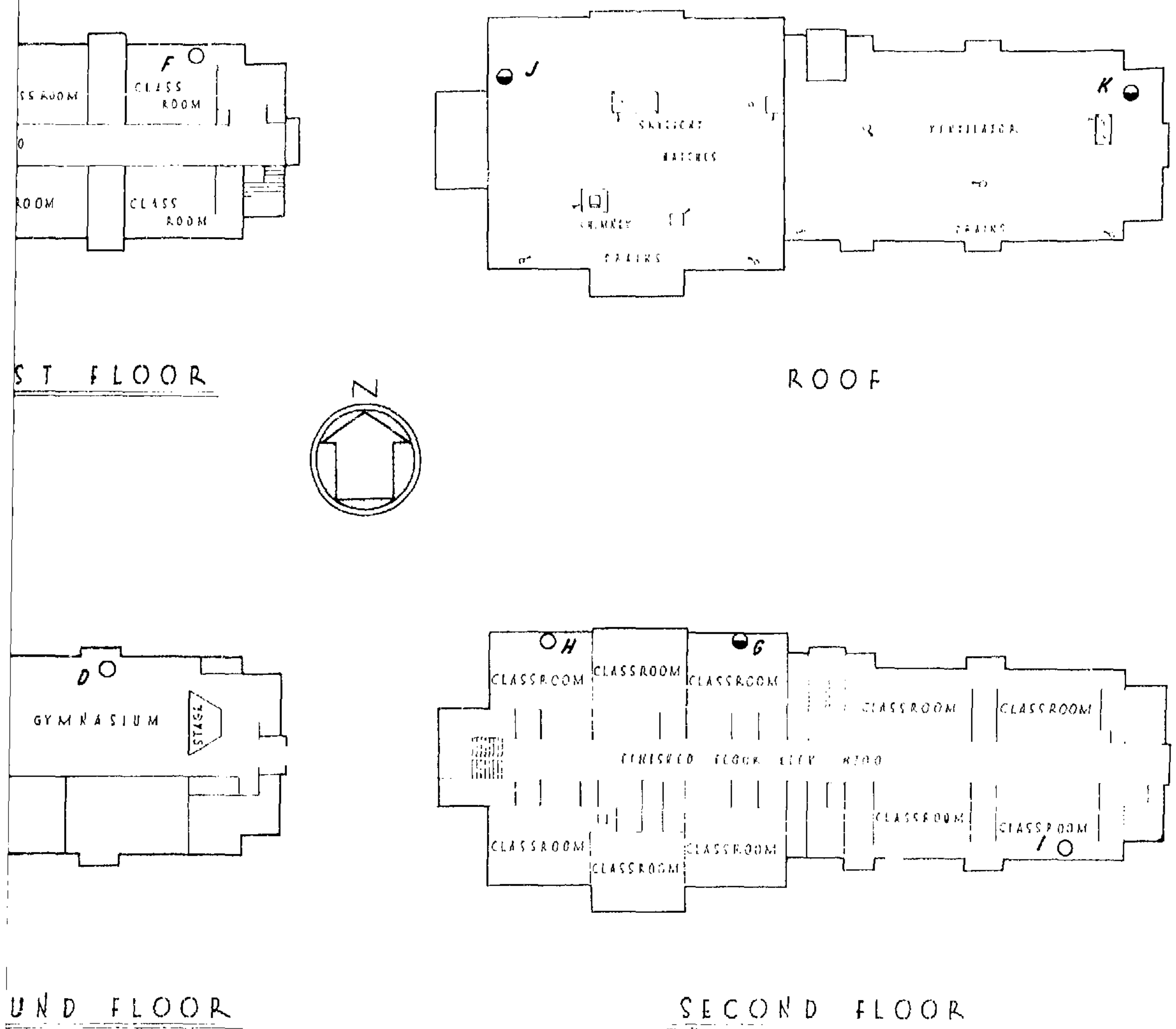
Sampler	FT 0010a	FT 0010b	FT 0010c	FT 0010d
	Test Number			
A	192	96	181	223
B	51	22	23	28
C	172	30	64	34
D	68	33	61	38
E	82	37	34	41
F	51	31	51	52
G	303	61	208	163
H	61	31	41	31
I	74	21	30	25
J	244	32	93	93
K	129	92	247	226

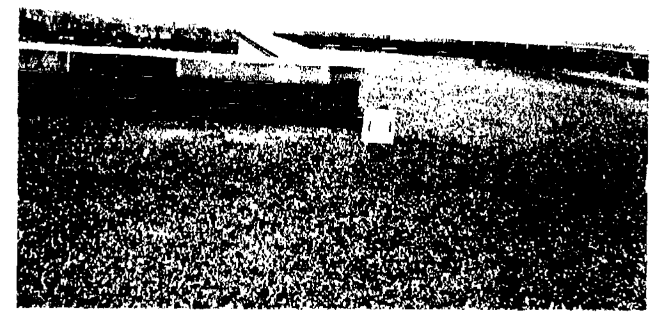
*Dosages are expressed in particle-minutes per liter; T represents trace dosage, i.e., a count not exceeding 15 fluorescent particles. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units. Sampling periods for a given release are listed in the respective isodosage charts appearing in Appendix B.

LEGEND

- ● Outside sampler on ground
- ◒ Outside sampler on roof or with filter holder out of window
- ○ Inside sampler







TYPICAL SAMPLER ON ROOF

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SECURITY INFORMATION

FIGURE V-30
CLINTON SCHOOL SAMPLER ARRAY AND RESULTS
FT 0010
11-12 FEBRUARY 1953

2

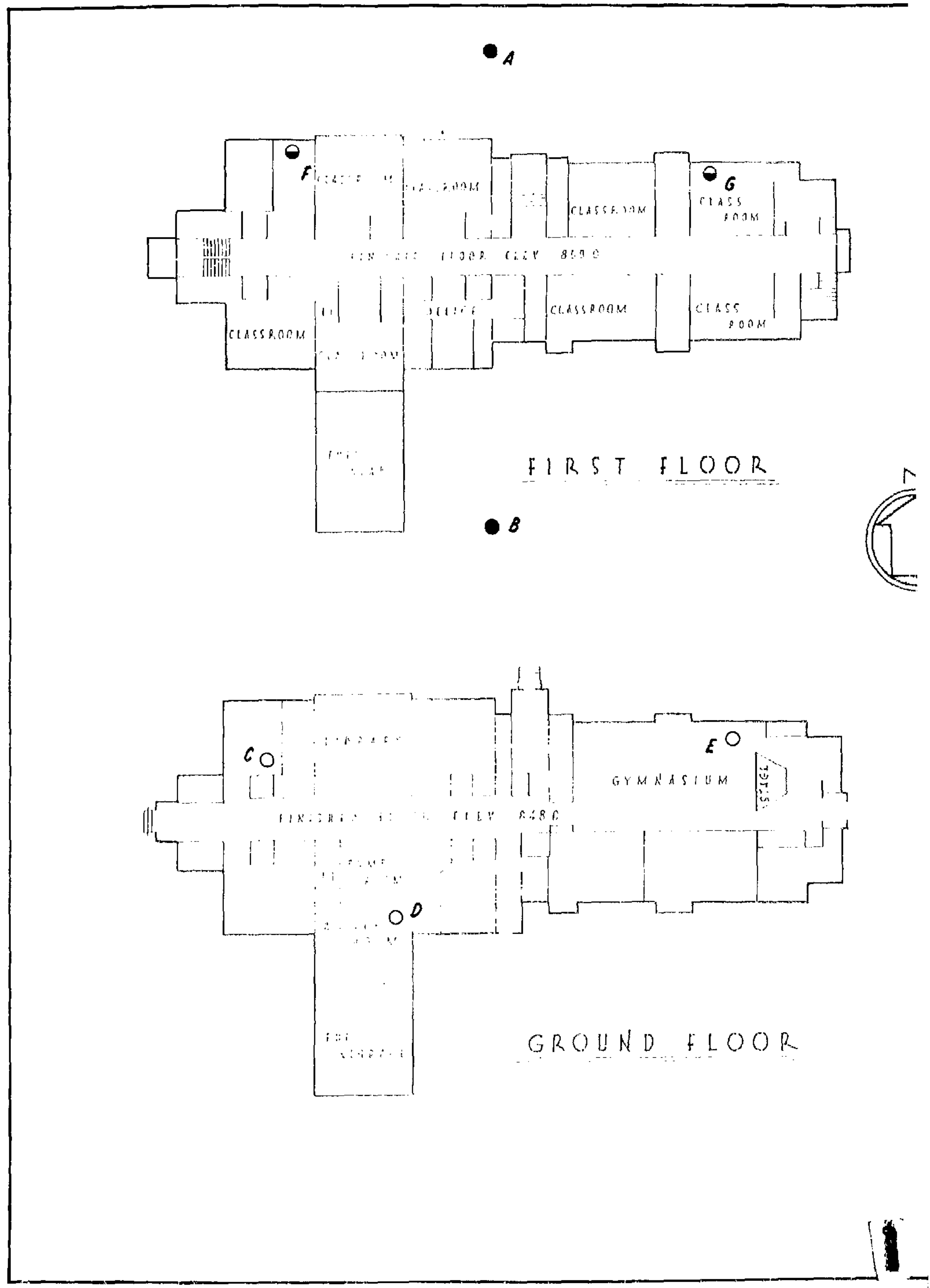
CLINTON SCHOOL DOSAGES*

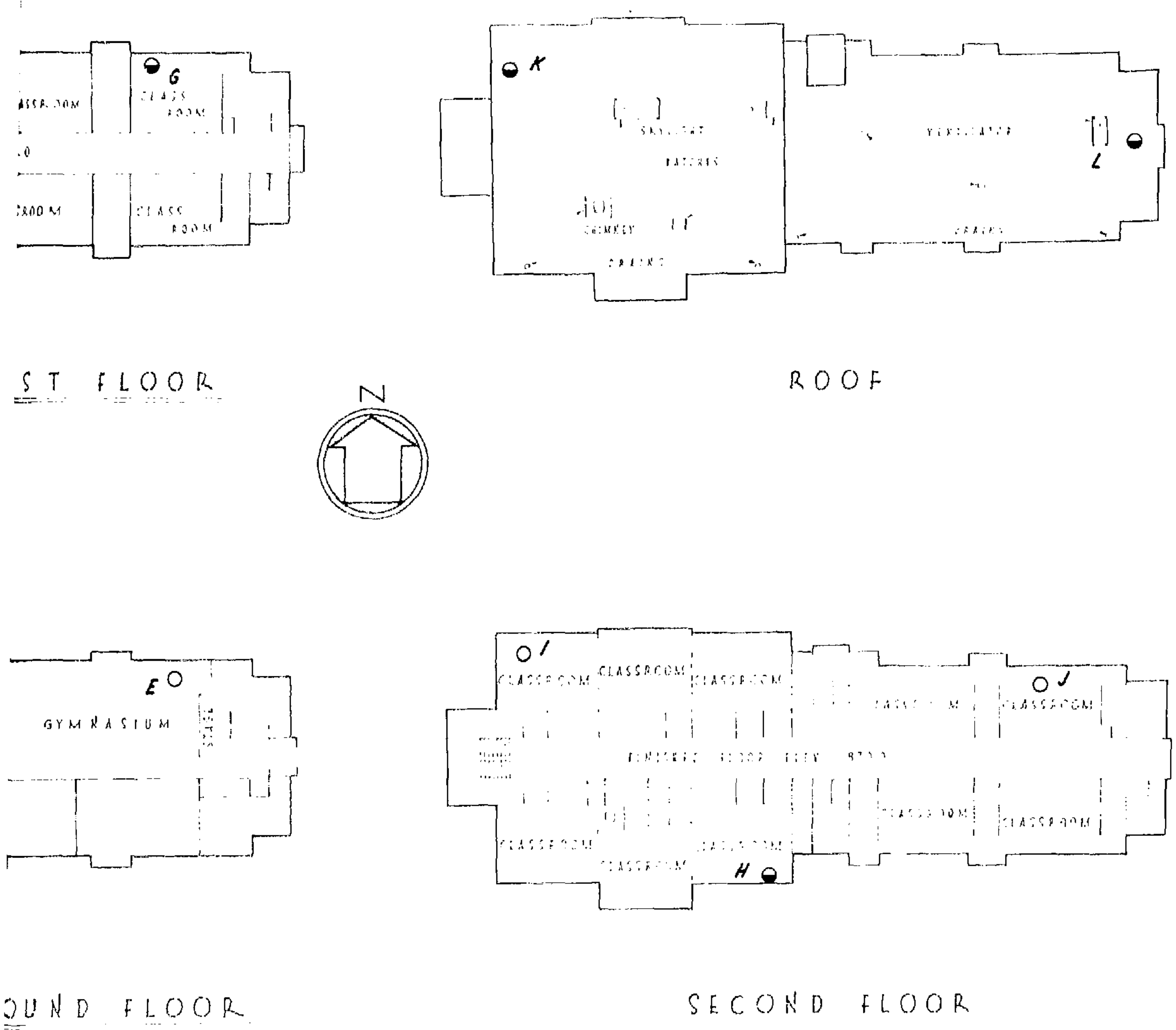
Sampler	Test Number FT 0011a		FT 0011b		FT 0011c	
A	8		41		0	
B	4		0		12	
C	T	8	6	2	19	T
D	3	T	23	T	7	3
E	4	3	19	10	5	T
F	8	T	41	17	19	T
G	11	T	31	T	T	4
H	M		36		7	
I	3	T	5	8	4	T
J	6	2	6	4	2	T
K	7		23		4	
L	11		36		T	

*Dosages are expressed in particle-minutes per liter; T represents trace dosage, i.e., a count not exceeding 15 fluorescent particles; M indicates data missing or equipment malfunction. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units. Sampling periods for a given release are listed in the respective isodosage charts appearing in Appendix B.

LEGEND

- ● Outside sampler on ground
- ◓ Outside sampler on roof or with filter holder out of window
- ○ Inside sampler





CLINTON SCHOOL, LOOKING NORTH
FROM 29th STREET

SECRET
SECURITY INFORMATION

FIGURE V-31
CLINTON SCHOOL SAMPLER
ARRAY AND RESULTS

FT 0011
15 FEBRUARY 1953

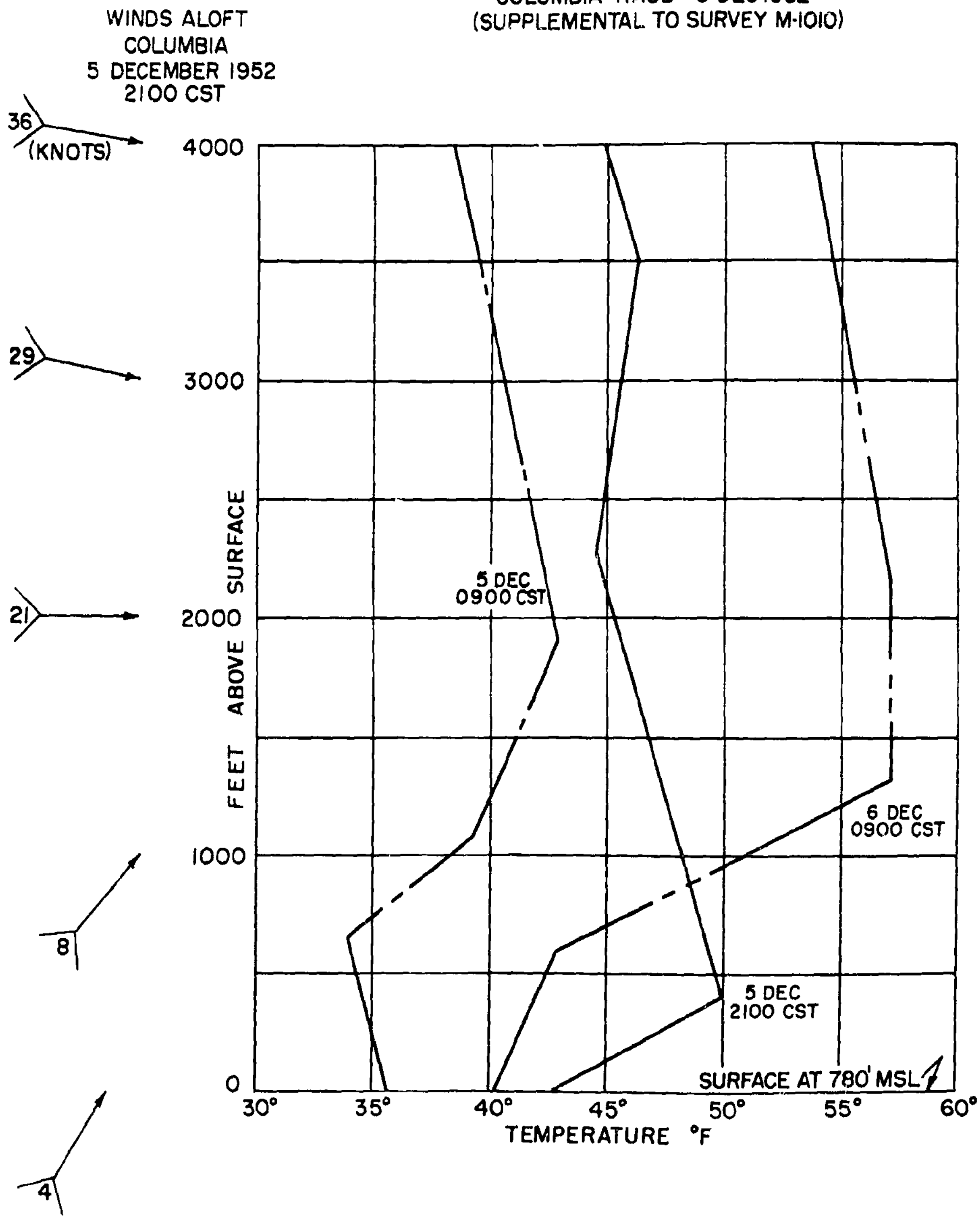
2

APPENDIX A
ST. LOUIS SURVEYS

APPENDIX "A"

FIGURE A-1

TEMPERATURE SOUNDINGS
COLUMBIA RAOB 5 DEC 1952
(SUPPLEMENTAL TO SURVEY M-1010)



SUMMARY OF REGIONAL AND LOCAL WEATHER

Survey M-1010, 5 December 1952

Synoptic Situation

No fronts had passed St. Louis within the previous 36 hours, and the closest frontal activity at survey time was warm frontogenesis occurring some 400 miles to the west. A polar high-pressure cell of 1027 mb extended from western New Mexico to southeast Texas. A major low-pressure area of 996 mb was moving northeastward from the Great Lakes. Surface wind flow was southwest 4-7 mph. Air flow at the 700-mb level was westerly at 40 mph.

Weather Reports from Lambert Field (St. Louis Airport)

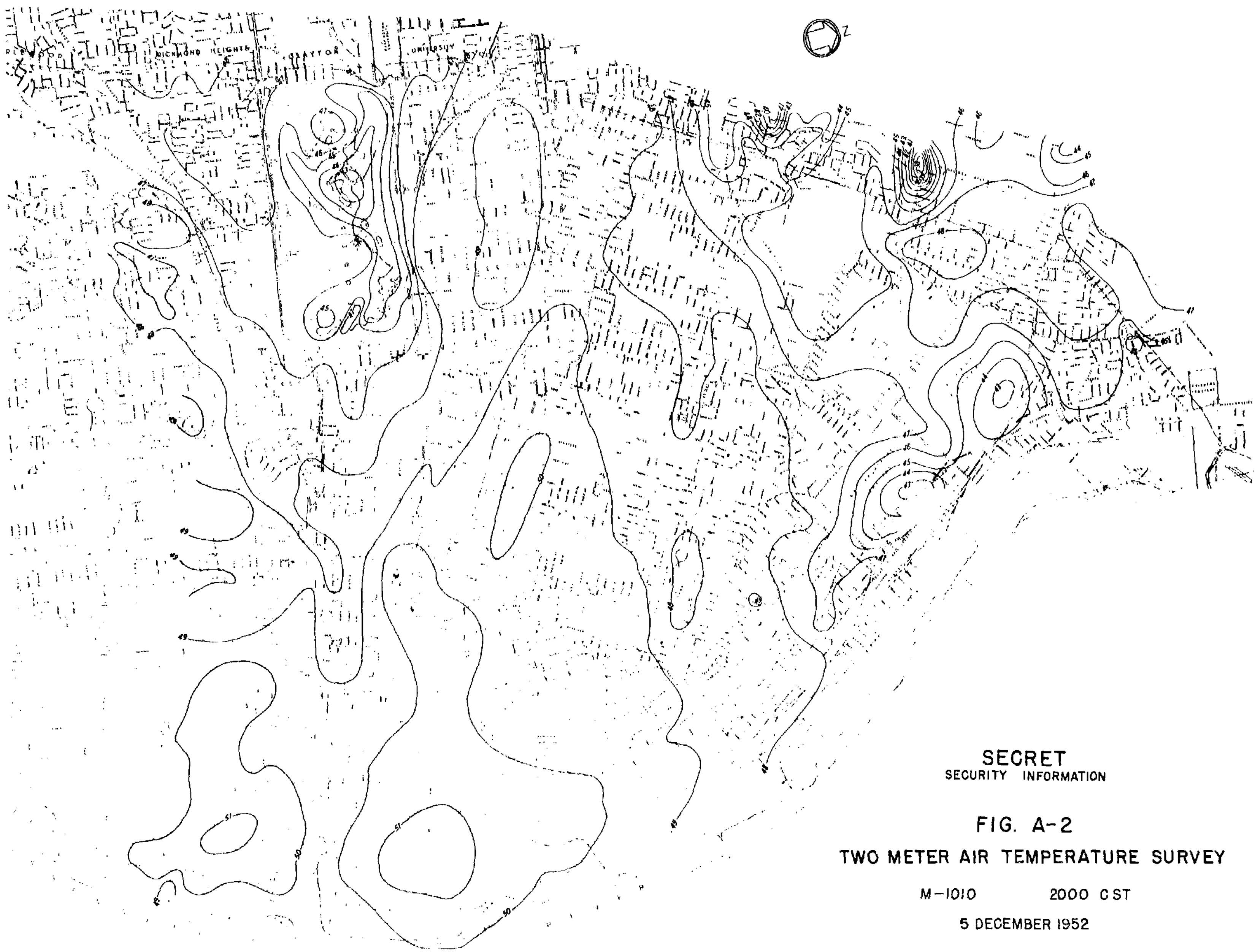
Time CST	Cloud Height (feet)	Sky Cover	Visibility (miles)	Weather*	Temp (°F)	Dew Point	Wind Airport Dir	Wind Airport Speed (mph)	Wind University Dir	Wind University Speed (mph)
1830		Clear	15		46	32	W	12	-	-
1930		Clear	15		45	31	W	11	NW	7
2030		Clear	15		44	31	W	9	NW	4
2130		Clear	15		42	31	W	5	NW	3
2230		Clear	15		41	31	W	9	-	-
2330		Clear	15		40	32	WSW	6	-	-

* And/or restriction to visibility

Sea-level pressure (Lambert Field, 2130 CST) : 1018.1 mb

Ground Condition: Bare and dry

Tree Cover: Bare



SECRET
SECURITY INFORMATION

FIG. A-2

TWO METER AIR TEMPERATURE SURVEY

M-1010 2000 CST

5 DECEMBER 1952

SUMMARY OF REGIONAL AND LOCAL WEATHER

Survey M-1010, 5 December 1952

Synoptic Situation

No fronts had passed St. Louis within the previous 36 hours, and the closest frontal activity at survey time was warm frontogenesis occurring some 400 miles to the west. A polar high-pressure cell of 1027 mb extended from western New Mexico to southeast Texas. A major low-pressure area of 996 mb was moving northeastward from the Great Lakes. Surface wind flow was southwest 4-7 mph. Air flow at the 700-mb level was westerly at 40 mph.

Weather Reports from Lambert Field (St. Louis Airport)

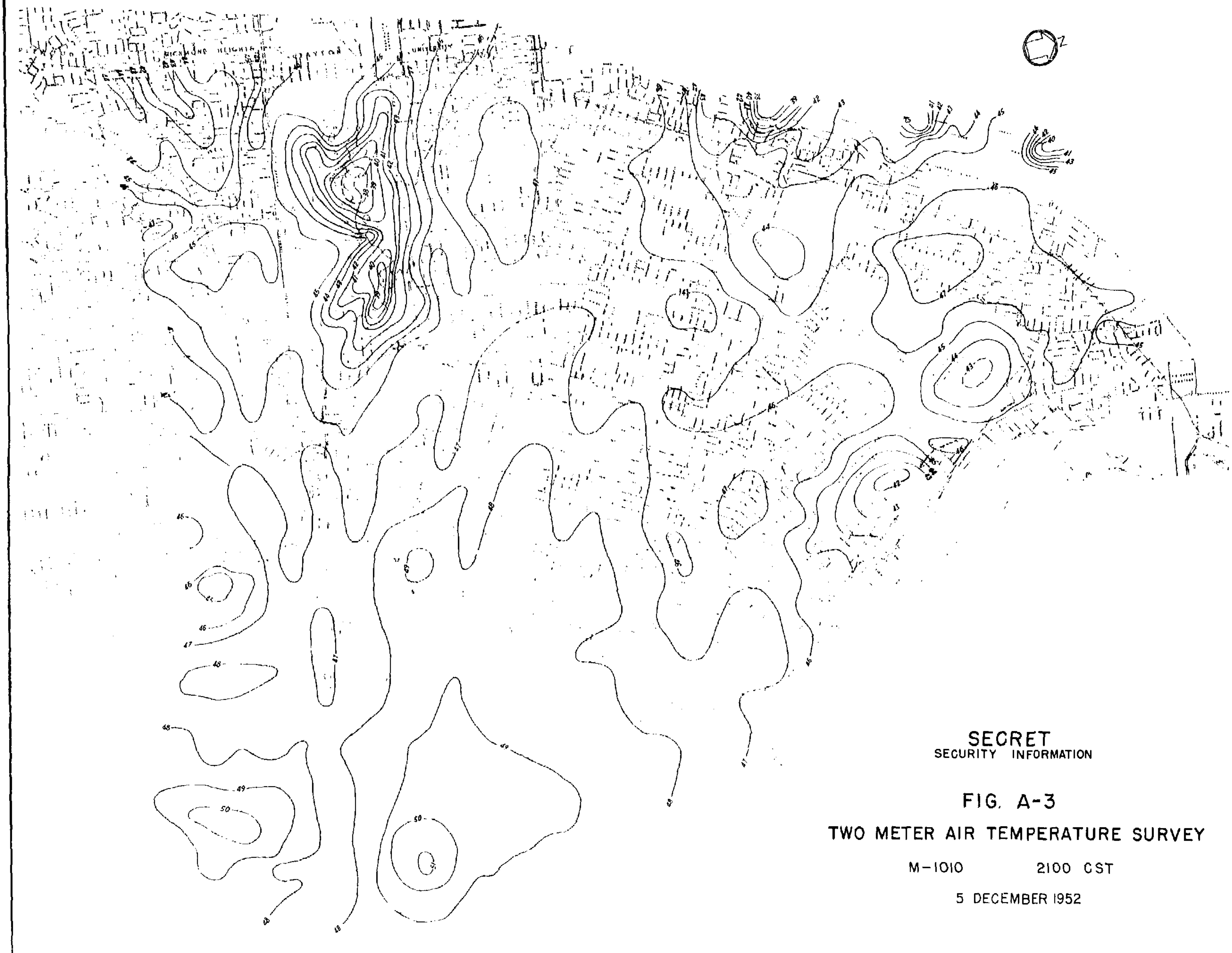
							Wind			
							Airport		University	
Time CST	Cloud Height (feet)	Sky Cover	Visibility (miles)	Weather*	Temp (°F)	Dew Point	Dir	Speed (mph)	Dir	Speed (mph)
1830		Clear	15		46	32	W	12	-	-
1930		Clear	15		45	31	W	11	NW	7
2030		Clear	15		44	31	W	9	NW	4
2130		Clear	15		42	31	W	5	NW	3
2230		Clear	15		41	31	W	9	-	-
2330		Clear	15		40	32	WSW	6	-	-

* And/or restriction to visibility

Sea-level pressure (Lambert Field, 2130 CST) : 1018.1 mb

Ground Condition: Bare and dry

Tree Cover: Bare



SECRET
SECURITY INFORMATION

FIG. A-3

TWO METER AIR TEMPERATURE SURVEY

M-1010 2100 CST

5 DECEMBER 1952

SUMMARY OF REGIONAL AND LOCAL WEATHER

Survey M-1010, 5 December 1952

Synoptic Situation

No fronts had passed St. Louis within the previous 36 hours, and the closest frontal activity at survey time was warm frontogenesis occurring some 400 miles to the west. A polar high-pressure cell of 1027 mb extended from western New Mexico to southeast Texas. A major low-pressure area of 996 mb was moving northeastward from the Great Lakes. Surface wind flow was southwest 4-7 mph. Air flow at the 700-mb level was westerly at 40 mph.

Weather Reports from Lambert Field (St. Louis Airport)

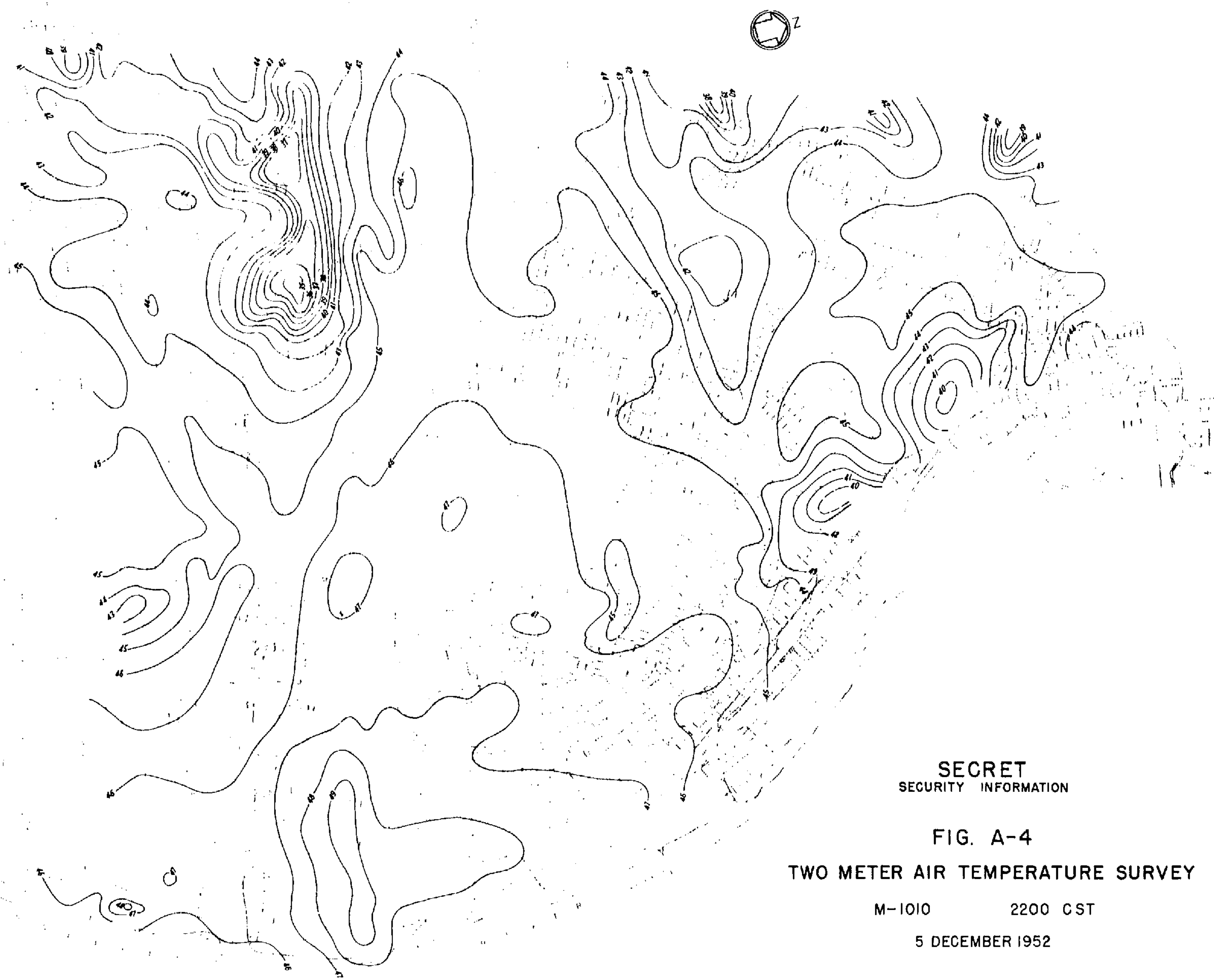
							Wind			
							Airport		University	
Time CST	Cloud Height (feet)	Sky Cover	Visibility (miles)	Weather*	Temp (°F)	Dew Point	Dir	Speed (mph)	Dir	Speed (mph)
1830		Clear	15		46	32	W	12	-	-
1930		Clear	15		45	31	W	11	NW	7
2030		Clear	15		44	31	W	9	NW	4
2130		Clear	15		42	31	W	5	NW	3
2230		Clear	15		41	31	W	9	-	-
2330		Clear	15		40	32	WSW	6	-	-

* And/or restriction to visibility

Sea-level pressure (Lambert Field, 2130 CST) : 1018.1 mb

Ground Condition: Bare and dry

Tree Cover: Bare



SECRET
SECURITY INFORMATION

FIG. A-4

TWO METER AIR TEMPERATURE SURVEY

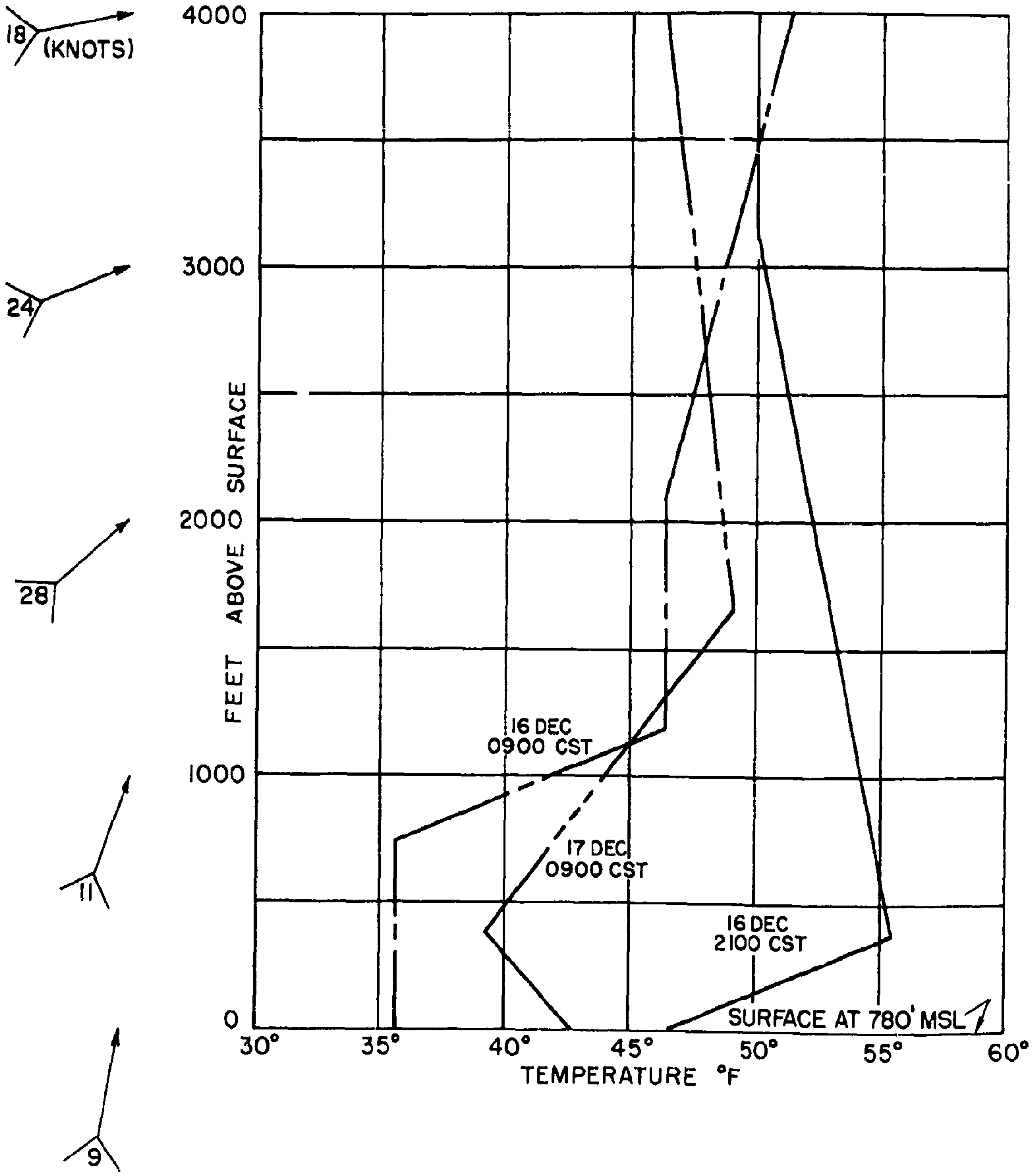
M-1010 2200 CST

5 DECEMBER 1952

FIGURE A-5

TEMPERATURE SOUNDINGS
COLUMBIA RAOB 16 DEC 1952
(SUPPLEMENTAL TO SURVEY M-1016)

WINDS ALOFT
COLUMBIA
16 DECEMBER 1952
2100 CST



SUMMARY OF REGIONAL AND LOCAL WEATHER

Survey M-1016, 16 December 1952

Synoptic Situation

A weak cold front oriented ENE-WSW was located approximately 300 miles to the north of St. Louis. This front was moving slowly southward and did not pass St. Louis until late the next day. A very weak warm front was approaching the station from the west and undergoing frontolysis. North of Edmonton a continental high-pressure cell of 1034 mb was centered and to the south of Mobile lay a maritime high of 1026 mb. A weak and inactive low of 1010 mb was located over northern Texas. Surface wind flow was generally south-southwest from 8-12 mph. At the 700 mb level the air flow was westerly at 20 mph.

Weather Reports from Lambert Field (St. Louis Airport)

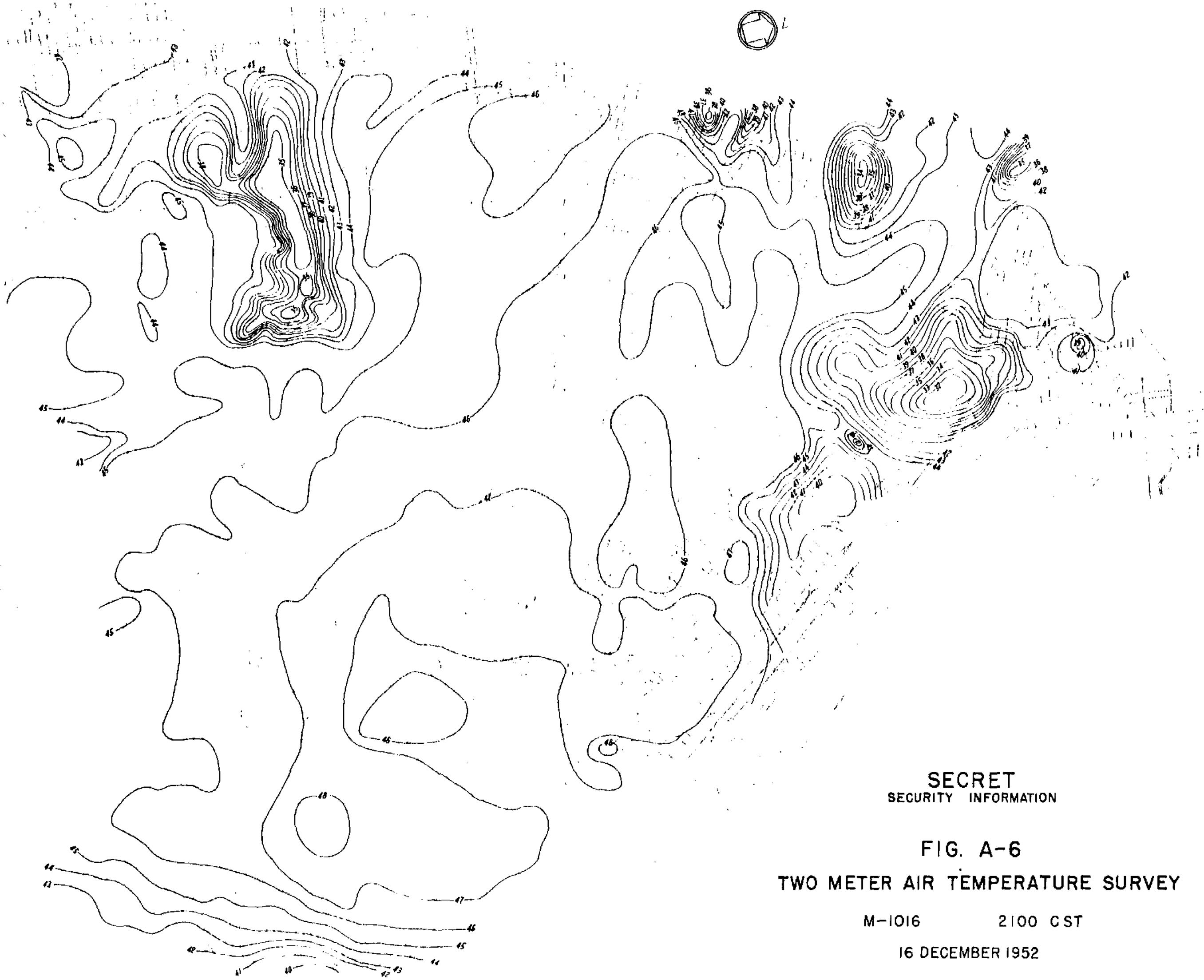
Time CST	Cloud Ht. (feet)	Sky Cover	Visibility (miles)	Weather*	Temp (°F)	Dew Point
1830		Clear	10		45	30
1930		Clear	8		45	31
2030		Clear	5	Smoke	42	30
2130		Clear	5	Smoke	42	30
2230		Clear	6	Smoke	39	29
2330		Clear	10		39	27

Wind Direction and Speed (mph)

Time CST	Federal Building (303 ft)	Lambert Field (59 ft)	St. Louis University (Rooftop)	Special Observation 1200 ft. S. Eads Bridge (4 ft)
1830		S 4		
1900		S 4		
1930		S 4	SE 2	
2000		S 5	S 3	
2030		S 5	S 3	
2100	SW 18	S 6	SSW 3	SSW 2
2130		S 8	S 3	
2200	SW 20	S 6	SSW 3	SW 5
2230		S 7		
2300	SW 20	S 8		

* And/or restriction to visibility

Sea level pressure (Lambert Field 2130 CST) : 1017.4 mb
Ground Condition: Bare and dry
Tree Cover: Bare



SECRET
SECURITY INFORMATION

FIG. A-6
TWO METER AIR TEMPERATURE SURVEY

M-1016 2100 CST

16 DECEMBER 1952

SUMMARY OF REGIONAL AND LOCAL WEATHER

Survey M-1016, 16 December 1952

Synoptic Situation

A weak cold front oriented ENE-WSW was located approximately 300 miles to the north of St. Louis. This front was moving slowly southward and did not pass St. Louis until late the next day. A very weak warm front was approaching the station from the west and undergoing frontolysis. North of Edmonton a continental high-pressure cell of 1034 mb was centered and to the south of Mobile lay a maritime high of 1026 mb. A weak and inactive low of 1010 mb was located over northern Texas. Surface wind flow was generally south-southwest from 8-12 mph. At the 700 mb level the air flow was westerly at 20 mph.

Weather Reports from Lambert Field (St. Louis Airport)

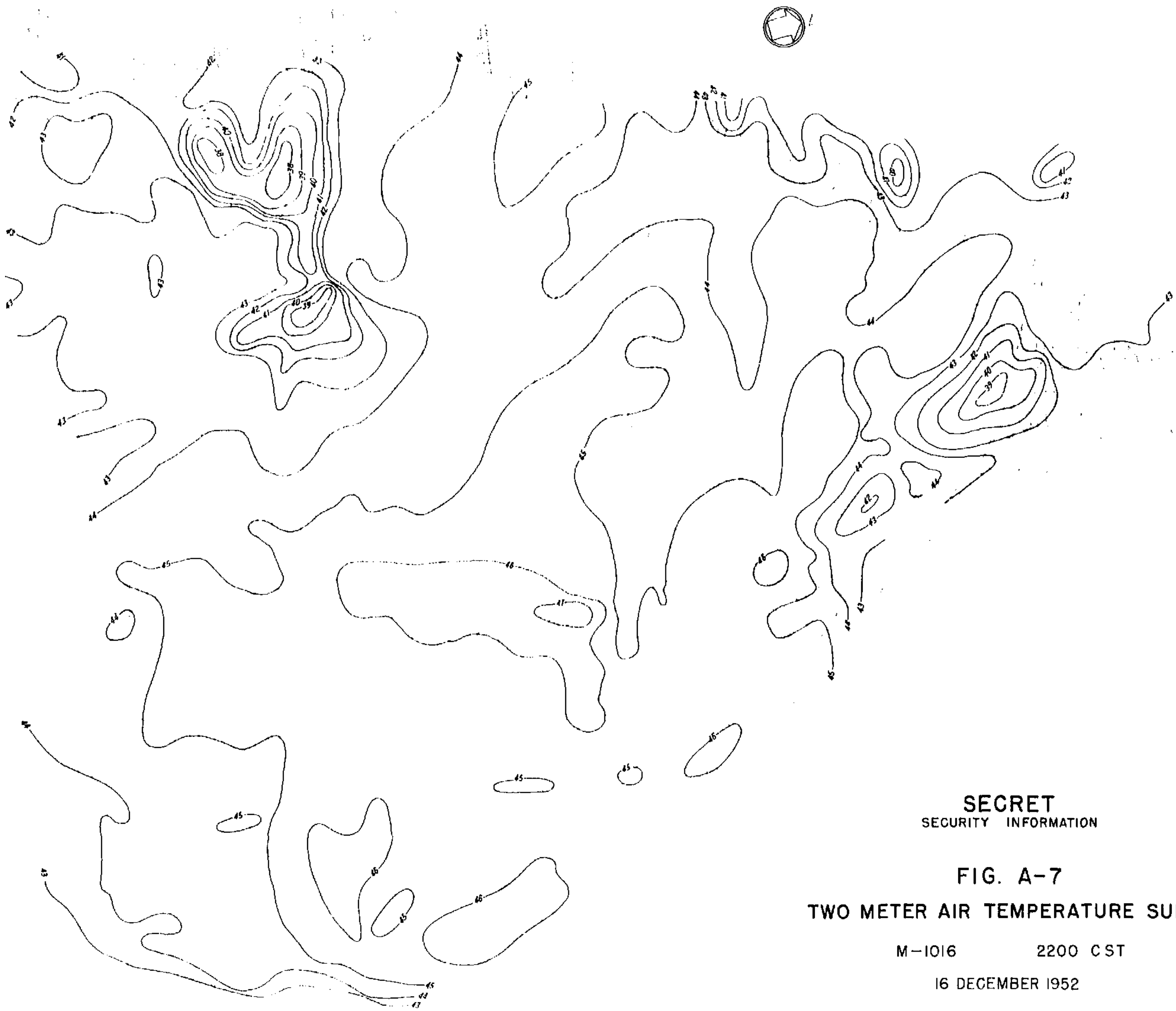
Time CST	Cloud Ht. (feet)	Sky Cover	Visibility (miles)	Weather*	Temp (°F)	Dew Point
1830		Clear	10		45	30
1930		Clear	8		45	31
2030		Clear	5	Smoke	42	30
2130		Clear	5	Smoke	42	30
2230		Clear	6	Smoke	39	29
2330		Clear	10		39	27

Wind Direction and Speed (mph)

Time CST	Federal Building (303 ft)		Lambert Field (59 ft)		St. Louis University (Rooftop)		Special Observation 1200 ft. S. Eads Bridge (4 ft)	
1830			S	4				
1900			S	4				
1930			S	4	SE	2		
2000			S	5	S	3		
2030			S	5	S	3		
2100	SW	18	S	6	SSW	3	SSW	2
2130			S	8	S	3		
2200	SW	20	S	6	SSW	3	SW	5
2230			S	7				
2300	SW	20	S	8				

* And/or restriction to visibility

Sea level pressure (Lambert Field 2130 CST) : 1017.4 mb
Ground Condition: Bare and dry
Tree Cover: Bare



SECRET
SECURITY INFORMATION

FIG. A-7

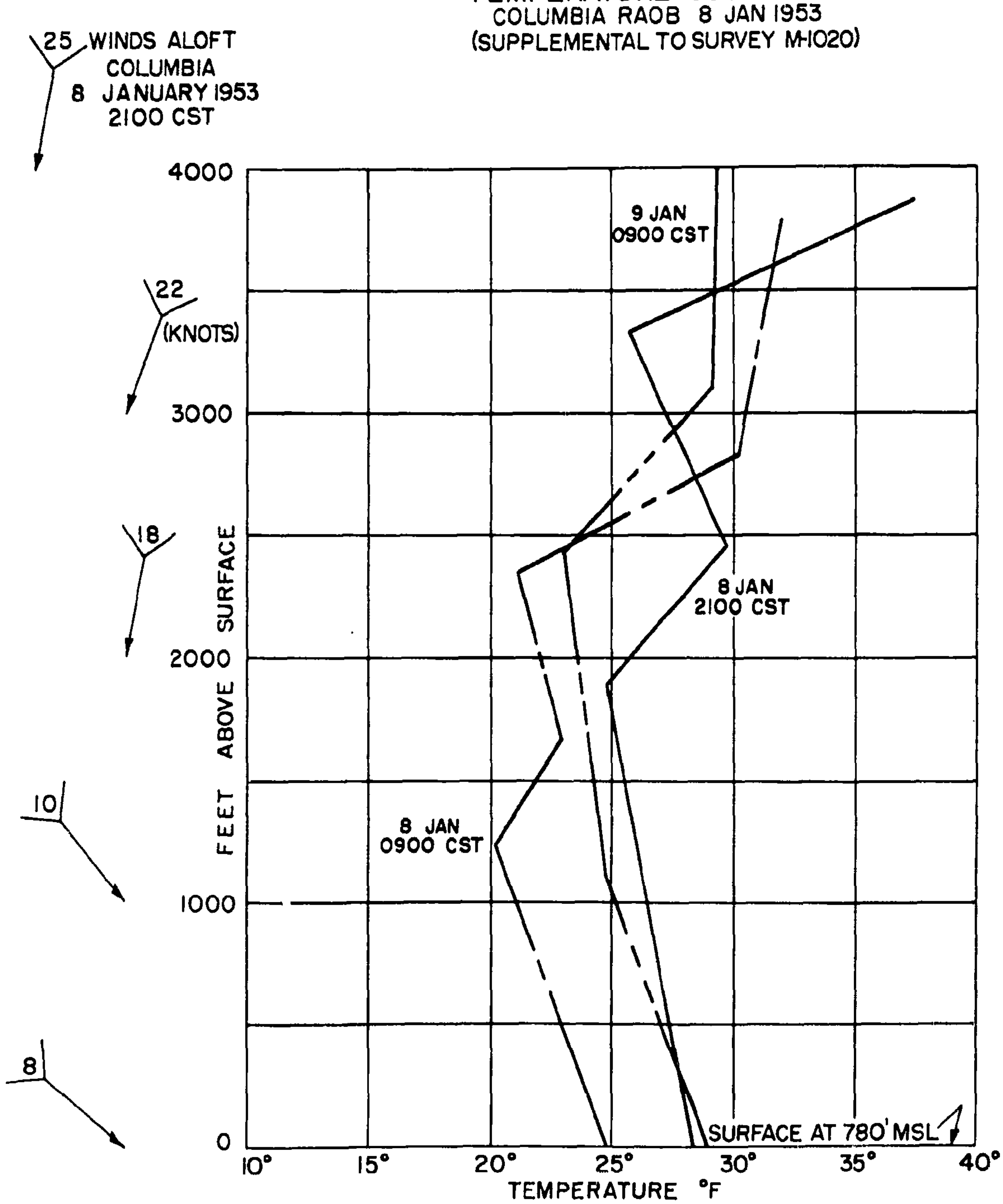
TWO METER AIR TEMPERATURE SURVEY

M-1016 2200 CST

16 DECEMBER 1952

FIGURE A-8

TEMPERATURE SOUNDINGS
COLUMBIA RAOB 8 JAN 1953
(SUPPLEMENTAL TO SURVEY M-1020)



SUMMARY OF REGIONAL AND LOCAL WEATHER

Survey M-1020, 8 January 1953

Synoptic Situation

An active front existed approximately 300 miles to the east of St. Louis with a 1000 mb low center in southern Alabama and the system was moving eastward. Considerable post-frontal weather observed throughout Illinois and Missouri was associated with an upper trough over this area. A Great Basin high-pressure cell of 1037 mb was located just southeast of Salt Lake. Surface wind flow was north 8-12 mph while at 700 mb the air flow was northwesterly at 25 mph.

Weather Reports from Lambert Field (St. Louis Airport)

Time CST	Cloud Height (feet)	Sky* Cover	Visibility (miles)	Weather**	Temp (°F)	Dew Point	Wind Airport Dir	Wind Airport Speed (mph)	Wind University Dir	Wind University Speed (mph)
1830	400	Over-cast	1 1/2	Freezing, drizzle and fog	29	28	NW	9	-	-
1930	400	"	1 1/2	"	29	28	NW	9	NW	6
2030	400	"	1 1/2	"	29	28	NW	7	NNW	6
2130	300	"	1 1/2	"	29	29	NW	8	NNW	4
2230	300	"	1 1/2	"	29	29	NW	7	-	-
2330	300	"	1	"	30	29	NW	10	-	-

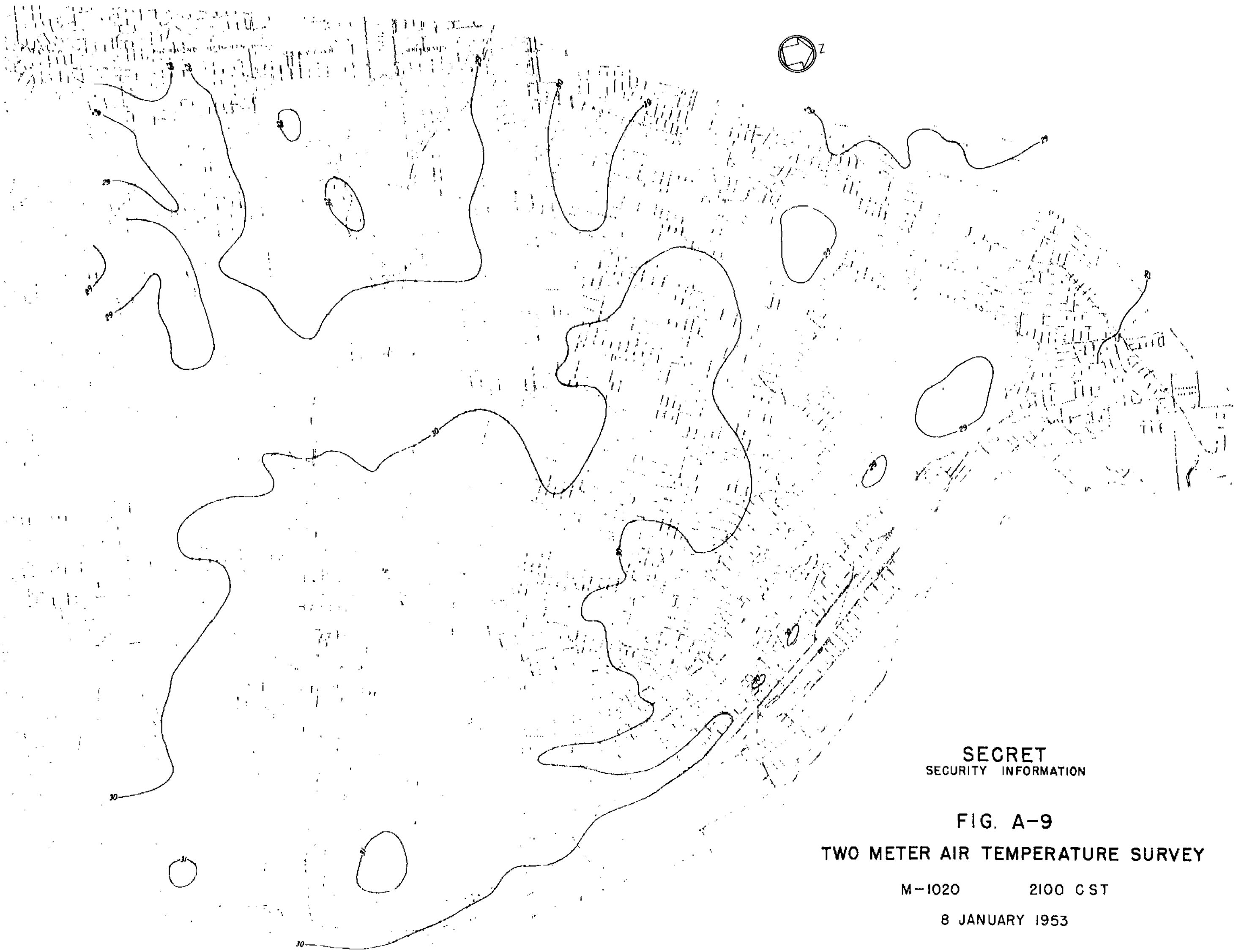
*Average cloudiness sunrise to sunset (Lambert Field): 100%

**And/or restriction to visibility

Sea level pressure (Lambert Field 2130 CST): 1014.4 mb

Ground condition: Snow and ice on ground. Lakes in Forest Park frozen.

Tree Cover: Bare



SECRET
SECURITY INFORMATION

FIG. A-9

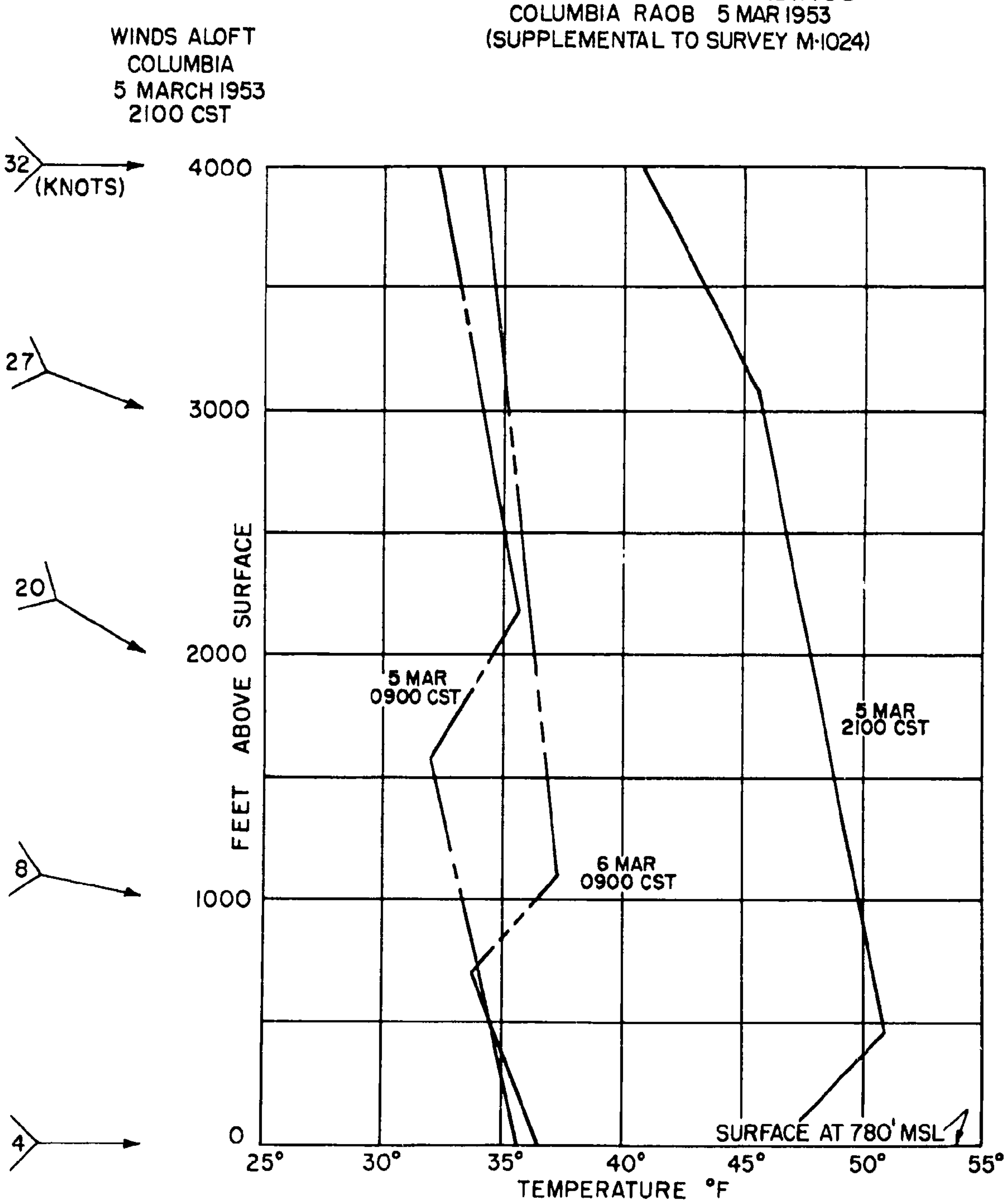
TWO METER AIR TEMPERATURE SURVEY

M-1020 2100 CST

8 JANUARY 1953

FIGURE A-10

TEMPERATURE SOUNDINGS
COLUMBIA RAOB 5 MAR 1953
(SUPPLEMENTAL TO SURVEY M-1024)



SUMMARY OF REGIONAL AND LOCAL WEATHER

Survey M-1024, 5 March 1953

Synoptic Situation:

Just north of St. Louis a weak stationary front was oriented east-west. Nearly clear skies prevailed to the south of the front, while light snow was falling from 100 - 200 miles to the north. High pressure dominated the Southeastern U.S. with central pressure of 1027 mb in the vicinity of Montgomery. An inactive low of 1015 mb was located over northern Texas. A strong polar high of 1036 mb was pushing southward through the Dakotas. Surface wind flow at St. Louis was west-southwest 8-12 mph. Wind flow at 700 mb was westerly at 45 mph.

Weather Reports from Lambert Field (St. Louis Airport)

Time CST	Cloud Height (feet)	Sky* Cover	Visibility (miles)	Weather**	Temp (°F)	Dew Point	Wind Airport Dir	Wind Airport Speed (mph)	Wind University Dir	Wind University Speed (mph)
1830	12000	Scattered	4	Smoke	48	35	ESE	8	-	-
1930		Clear	5	Smoke	47	36	SE	8	SW	7
2030		Clear	6	Smoke	46	36	SE	7	S	2
2130		Clear	8		47	35	S	9	SW	3
2230		Clear	8		46	34	W	8	-	-
2330		Clear	10		43	34	W	9	-	-

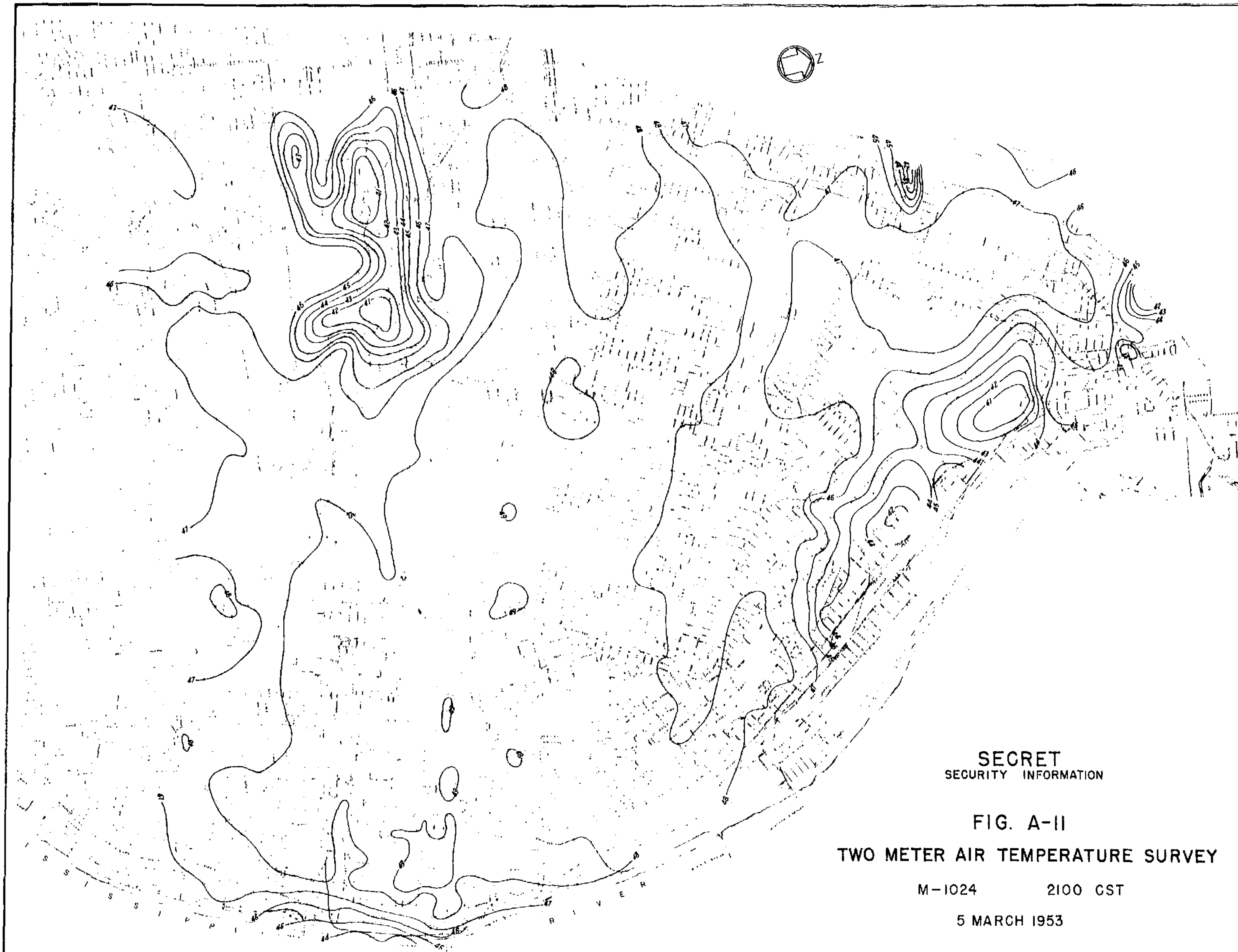
* Average cloudiness sunrise to sunset (Lambert Field)

** And/or restriction to visibility

Sea level pressure (Lambert Field 2130 CST) : 1018.1 mb

Ground Condition: Bare and dry

Tree cover: Bare



SECRET
SECURITY INFORMATION

FIG. A-11

TWO METER AIR TEMPERATURE SURVEY

M-1024 2100 CST

5 MARCH 1953

APPENDIX "B"

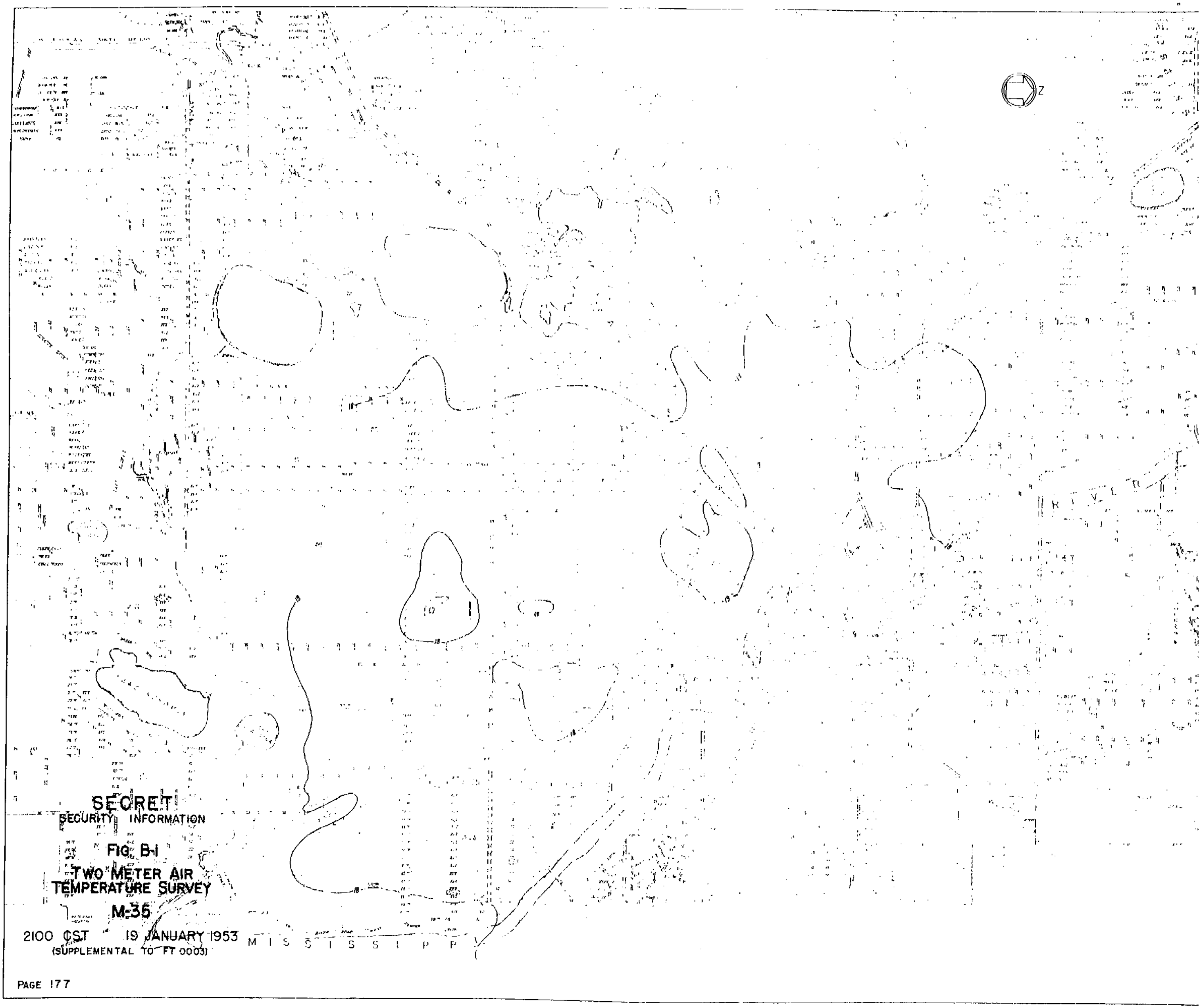


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FIG. B-1
TWO METER AIR TEMPERATURE SURVEY
M-35
2100 CST 19 JANUARY 1953
(SUPPLEMENTAL TO FT 0003)

SUMMARY OF REGIONAL AND LOCAL WEATHER

FT 0003 Survey M-35 19 Jan 1953

Synoptic Situation

A cold front lay some 400 miles to the south of Minneapolis through southern Missouri and Indiana. Snow flurries had occurred at Minneapolis and surroundings several hours before test time. An artic high cell of 1025 mb was centered approximately 400 miles to the northeast of International Falls. The nearest major low pressure area was inactive. It was located in eastern Texas with central pressure of 1006 mb. Surface wind flow was northerly at 8 to 12 mph. The air flow at the 700 mb level was from the west-northwest at 35 mph.

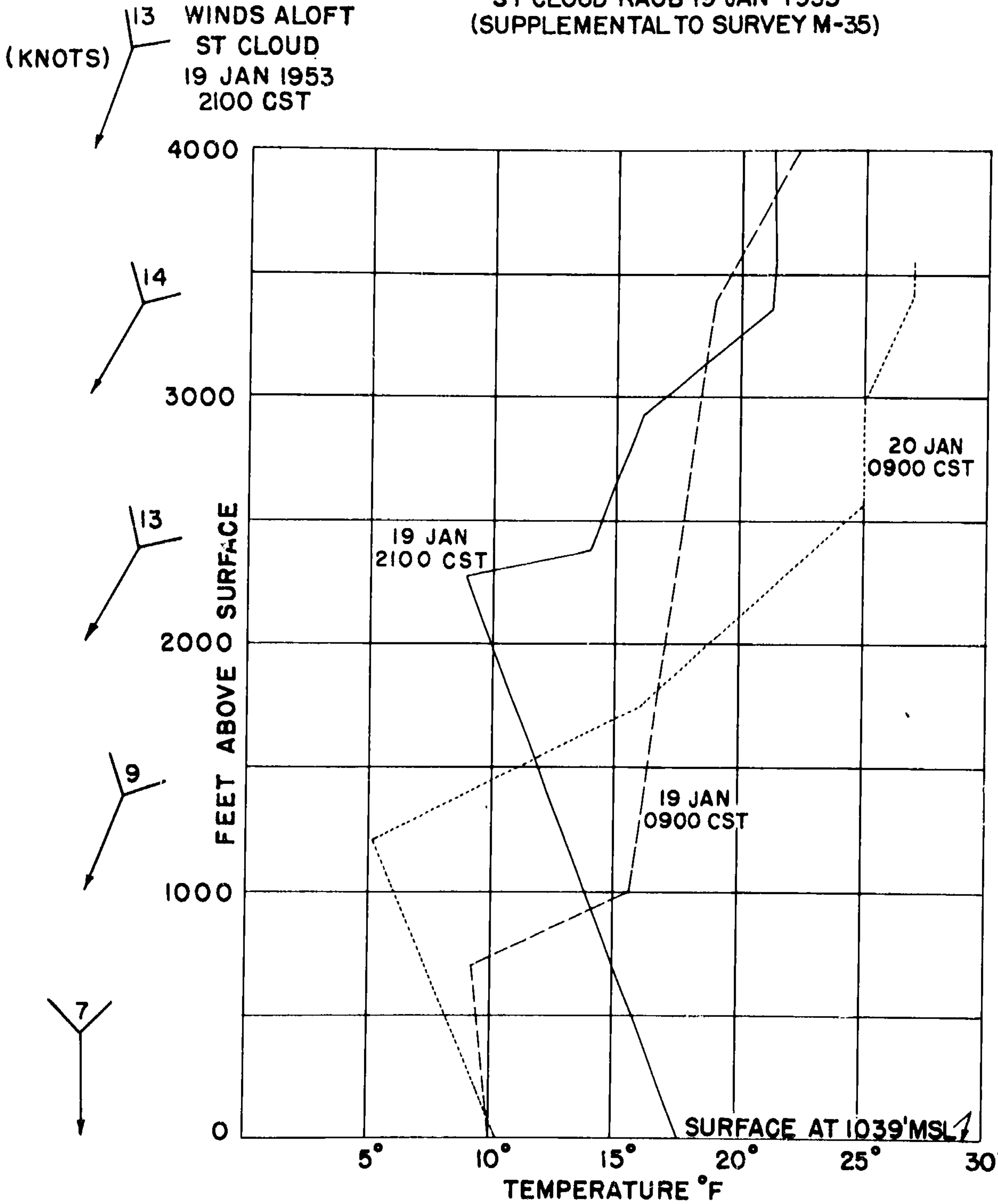
Weather Reports from Wold Chamberlain Field (Minneapolis)

Time CST	Cloud Height (feet)	Sky* Cover	Visibility (miles)	Weather**	Temp (°F)	Dew Point	Wind Dir	Wind Speed (mph)
1830	2100	Overcast	7		19	14	N	10
1930	1900	Overcast	10		18	13	N	10
2030	1600	Overcast	10		18	13	N	10
2130	1500	Overcast	10		18	12	N	8
2230	1600	Overcast	10		18	12	NNE	8
2330	1500	Overcast	12		18	12	NNE	10

Sea level pressure at 2130 CST: 1018.6 mb
Ground condition: Complete coverage 6" snow pack Lakes frozen with snow cover
Tree cover: None
* Average cloudiness sunrise to sunset: 100%
** and/or restrictions to visibility

FIGURE B-2

TEMPERATURE SOUNDINGS
ST CLOUD RAOB 19 JAN 1953
(SUPPLEMENTAL TO SURVEY M-35)



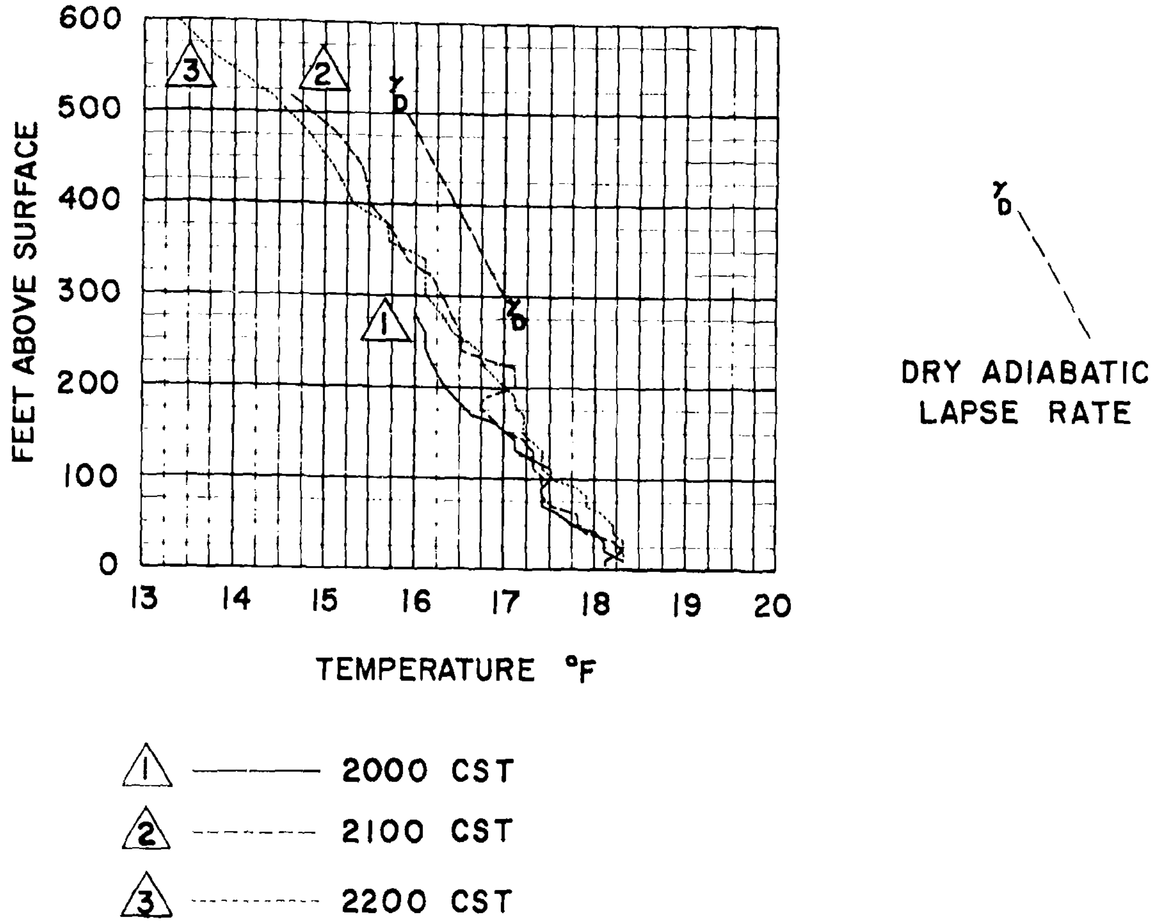


FIGURE B-3
TEMPERATURE SOUNDINGS
MINNEAPOLIS RESIDENTIAL
WIRESONDE
SURVEY M-35 19 JAN. 1953

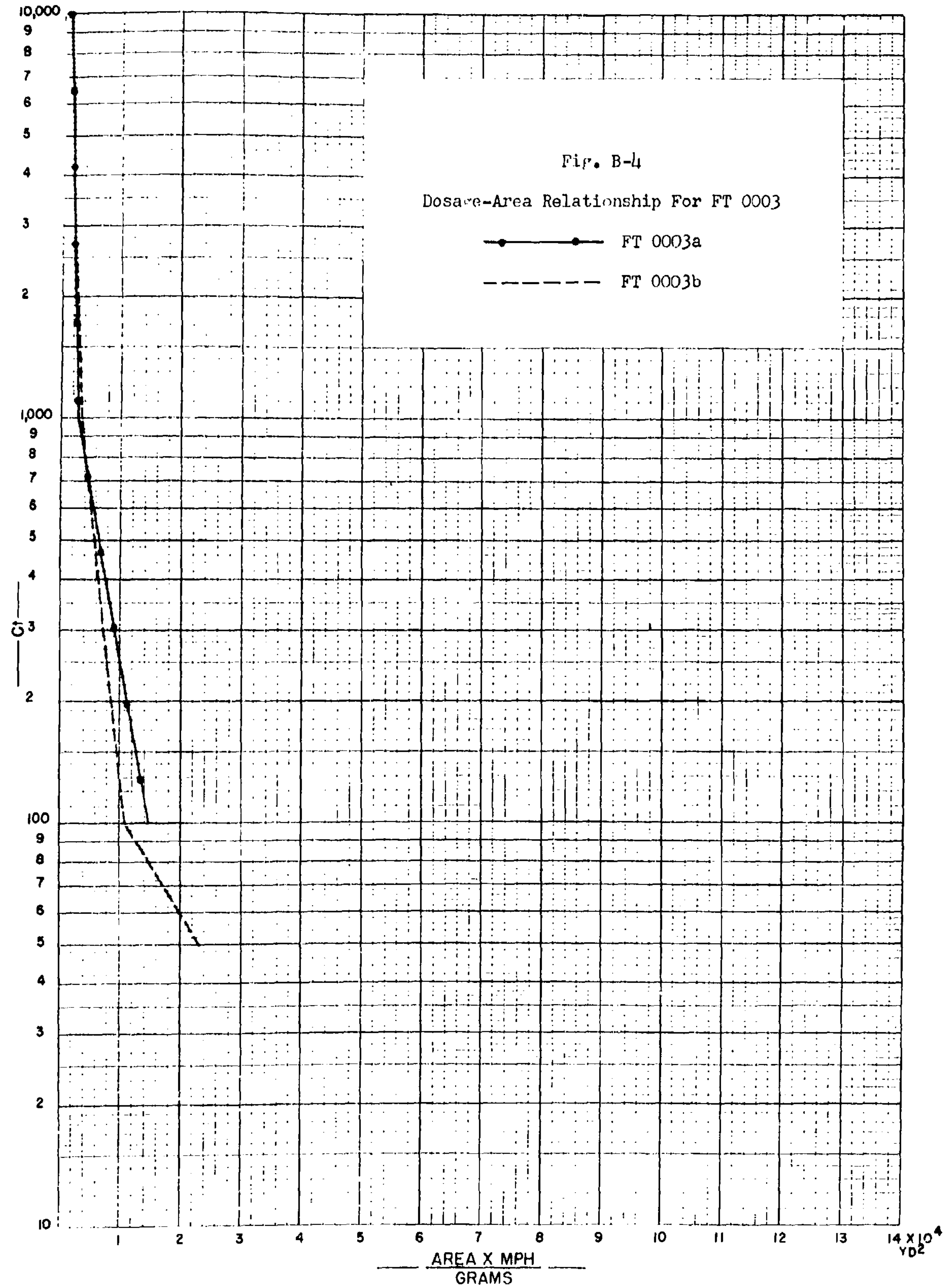


Fig. B-4
Dosage-Area Relationship For FT 0003
FT 0003a
FT 0003b
10,000
1,000
100
10
Ct
1
2
3
4
5
6
7
8
9
10
11
12
13
14 x 10^4 YD^2
AREA X MPH
GRAMS

AEROSOL GENERATION

Point-source release of 7.7 gms of NJZ 2266 over a period of 5 minutes starting at 2032 CST from a vehicle-mounted blower disperser located at point .

SAMPLING

Location and Exposure

Membrane-filter sampling equipment located at 40 stations as shown on test-array map by following symbols:

● Outdoor sampler at height between 1 and 6 feet.

◒ Outdoor sampler at height above or below general terrain level as indicated by note.

○ Indoor sampler at location indicated by test-array map or text.

Results

All samplers operated to measure total dosages.

Total Dosage (particle-minutes per liter)

● 58

T = trace dosage
M = malfunction or data missing

500 500 Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as M1 and M2 .

Similar observations at rooftop level (35 feet above surface) and wiresonde ascents made at meteorological station M3 .

2100 2105 2110 Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between the times indicated.

2145 Balloon track representing wind-drift observation at the time indicated.

Winds

Estimated roof-level winds westerly at 2-3 mph; street-level winds northwesterly at 2.2 mph.

Stability

2.2° F lapse from 6-300 ft.

Sky

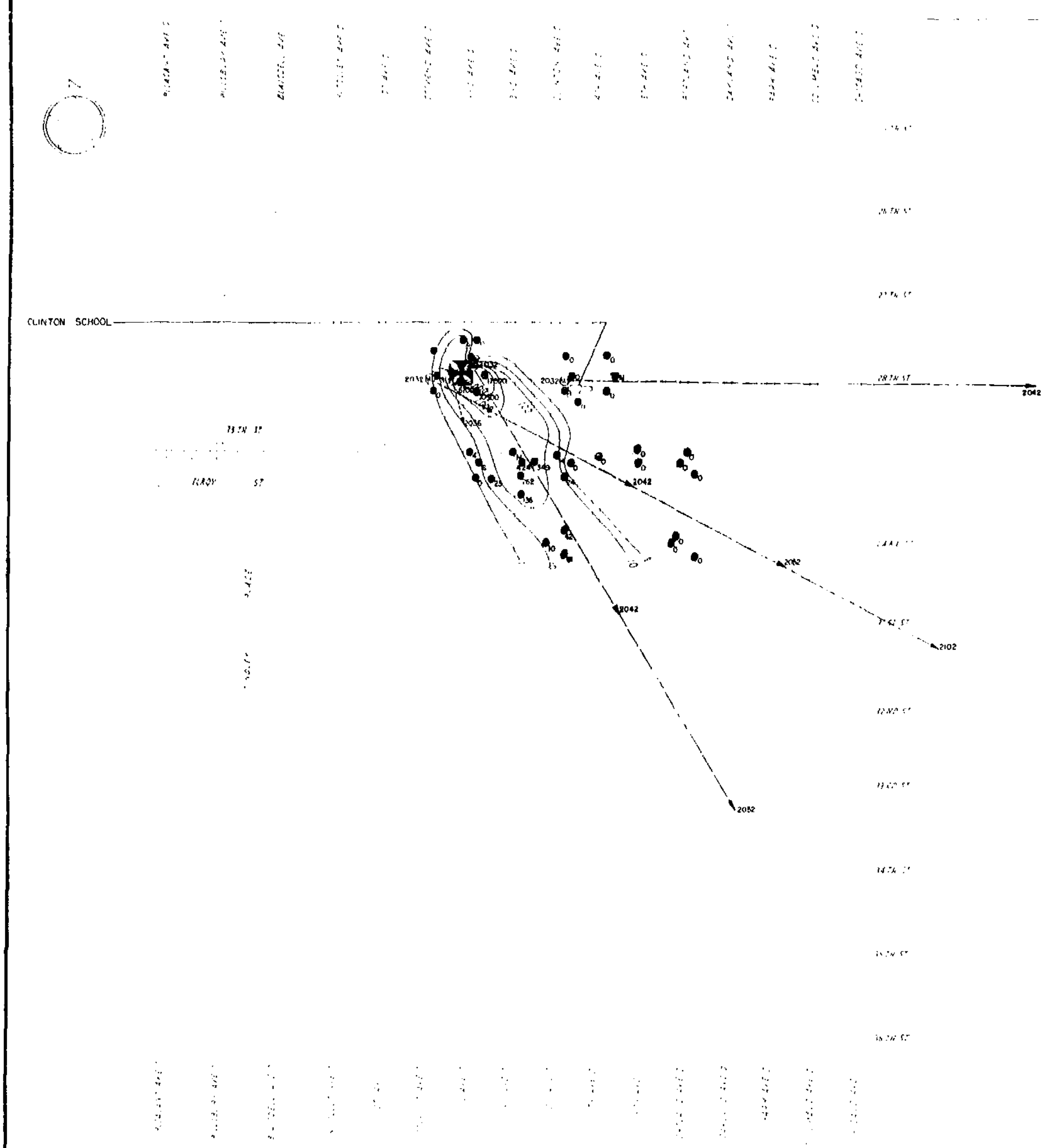
Overcast low clouds with base 1600 ft above the surface.

Temperature

18° F at 2 meters in the test area.

Moisture

Mixing ratio of 1.7 gm/kgm dry air.



SECRET
SECURITY INFORMATION

FIGURE B-5
TEST ARRAY AND RESULTS
FT 0003a 2032 CST
JANUARY 19, 1953

AEROSOL GENERATION

Point-source release of 6.9 gms of NJZ 2266 over a period of 5 minutes starting at 2125 CST from a vehicle-mounted blower disperser located at point ✠ .

SAMPLING

Location and Exposure

Membrane-filter sampling equipment located at 40 stations as shown on test-array map by following symbols:

● Outdoor sampler at height between 1 and 6 feet.

◒ Outdoor sampler at height above or below general terrain level as indicated by note.

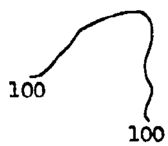
○ Indoor sampler at location indicated by test-array map or text.

Results

All samplers operated to measure total dosages.

● 58 ← Total Dosage (particle-minutes per liter)

T = trace dosage
M = malfunction or data missing



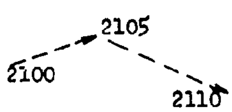
Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

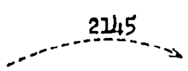
Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as M1 and M2 .

Similar observations at rooftop level (35 feet above surface) and wiresonde ascents made at meteorological station M3 .



Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between the times indicated.



Balloon track representing wind-drift observation at the time indicated.

Winds

Estimated roof-level winds westerly at 2-3 mph; street-level winds northwesterly at 1.2 mph.

Stability

2.1° F lapse from 6-300 ft.

Sky

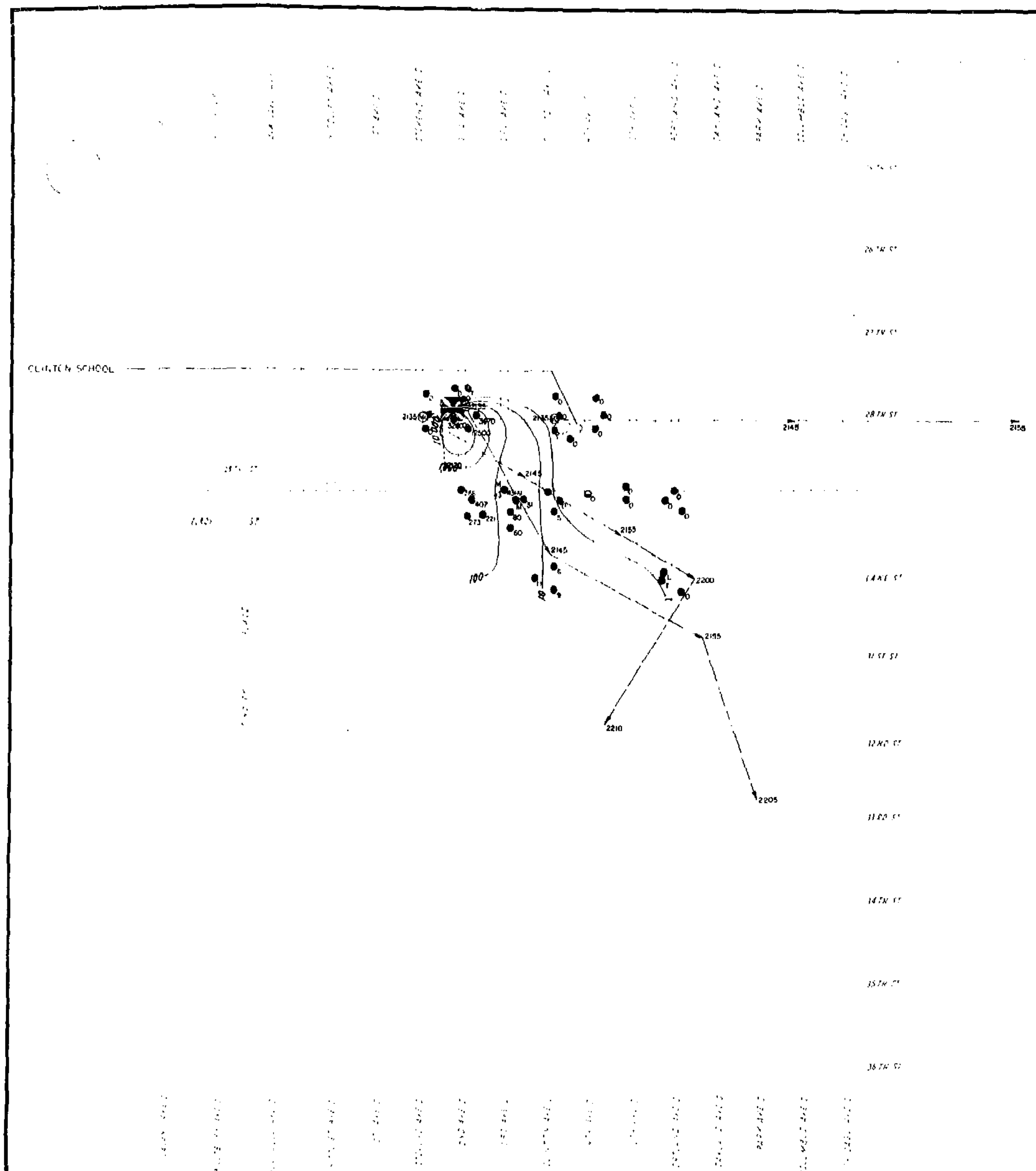
Overcast low clouds with base 1600 ft above the surface.

Temperature

18° F at 2 meters in the test area.

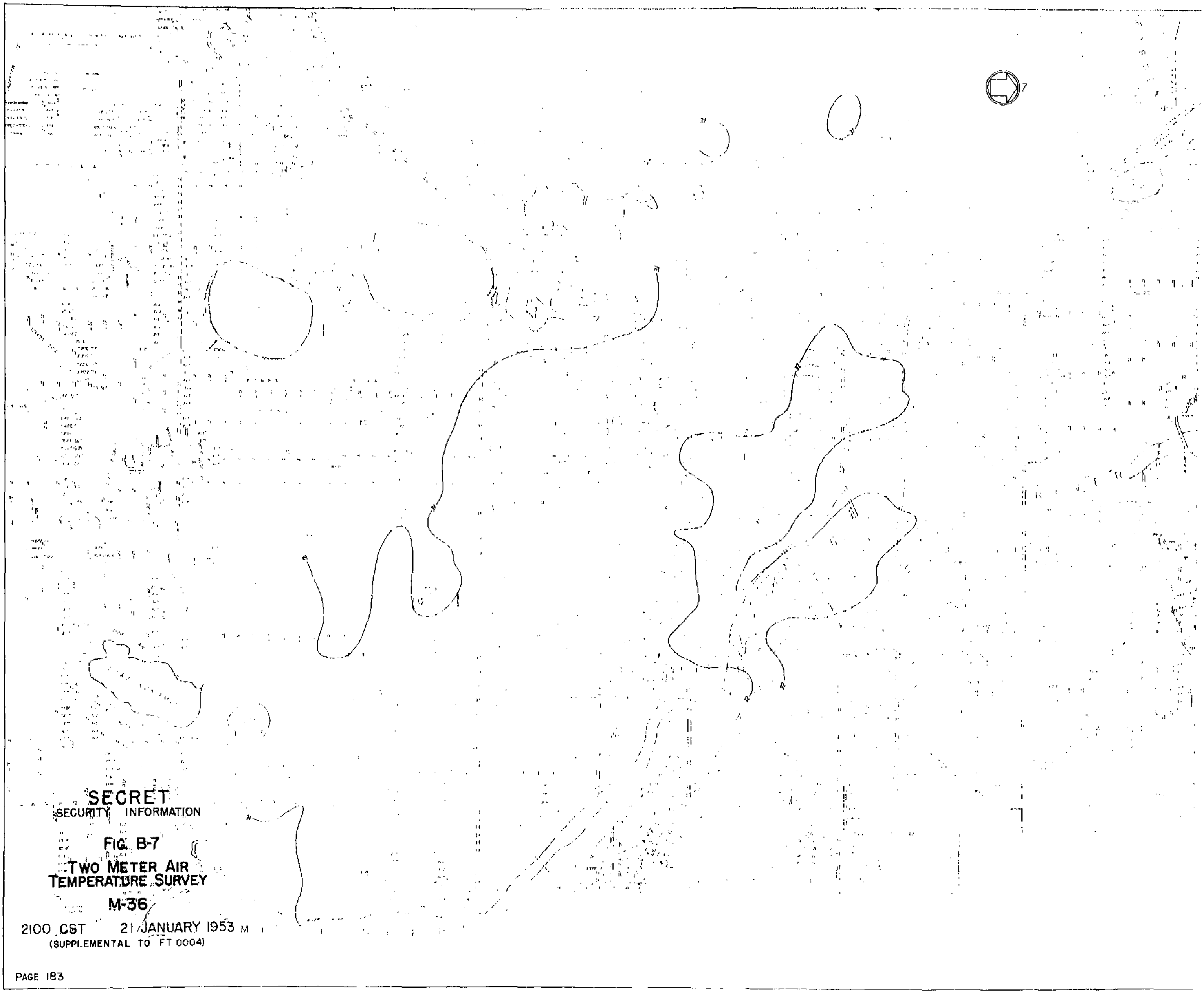
Moisture

Mixing ratio of 1.7 gm/kgm dry air.



SECRET
SECURITY INFORMATION

FIGURE B-6
TEST ARRAY AND RESULTS
FT 0003b 2135 CST
JANUARY 19,1953



SECRET
SECURITY INFORMATION

FIG. B-7
TWO METER AIR
TEMPERATURE SURVEY
M-36
2100 CST 21 JANUARY 1953 M
(SUPPLEMENTAL TO FT 0004)

SUMMARY OF REGIONAL AND LOCAL WEATHER

FT 0004 Survey M-36 21 Jan 1953

Synoptic Situation

A weak semi-stationary front was oriented northeast - southwest just to the west of Minneapolis. This front was associated with a 1000 mb low center over northwestern Texas. Snow flurries generally accompanied this front. Surface flow was easterly at 8 to 12 mph. Air flow at 700 mb was southwesterly at 15 to 20 mph.

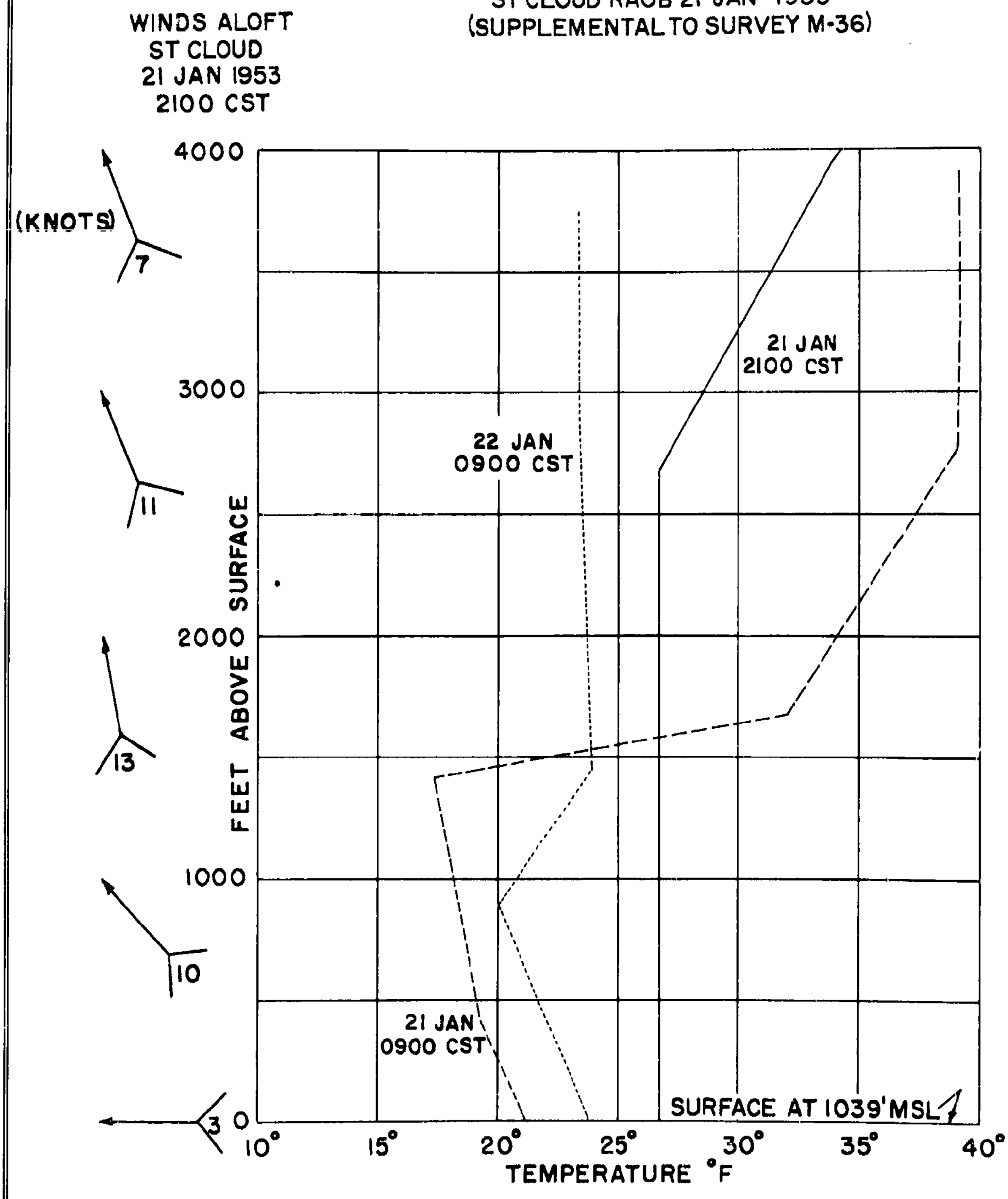
Weather Reports from Wold-Chamberlain Field (Minneapolis)

Time CST	Cloud Height (feet)	Sky* Cover	Visibility (miles)	Weather**	Temp (°F)	Dew Point	Wind Dir	Wind Speed (mph)
1830	1200	Over-cast	3	Fog	30	28	ESE	6
1930	1500	Over-cast	5	Fog	30	29	E	11
2030	1500	Brok-en	5	Fog	31	29	ESE	11
2130	1300	Scat-tered	5	Fog	31	29	ESE	11
2230	1300	Scat-tered	6	Fog	30	29	ESE	9

Sea level pressure at 2130 CST: 1013.9 mb
Ground condition: 6" snow pack Ice and dirty snow on streets Lakes frozen and snow covered
Tree cover: None
* Average cloudiness sunrise to sunset: 100%
** and/or restriction to visibility

FIGURE B-8

TEMPERATURE SOUNDINGS
ST CLOUD RAOB 21 JAN 1953
(SUPPLEMENTAL TO SURVEY M-36)



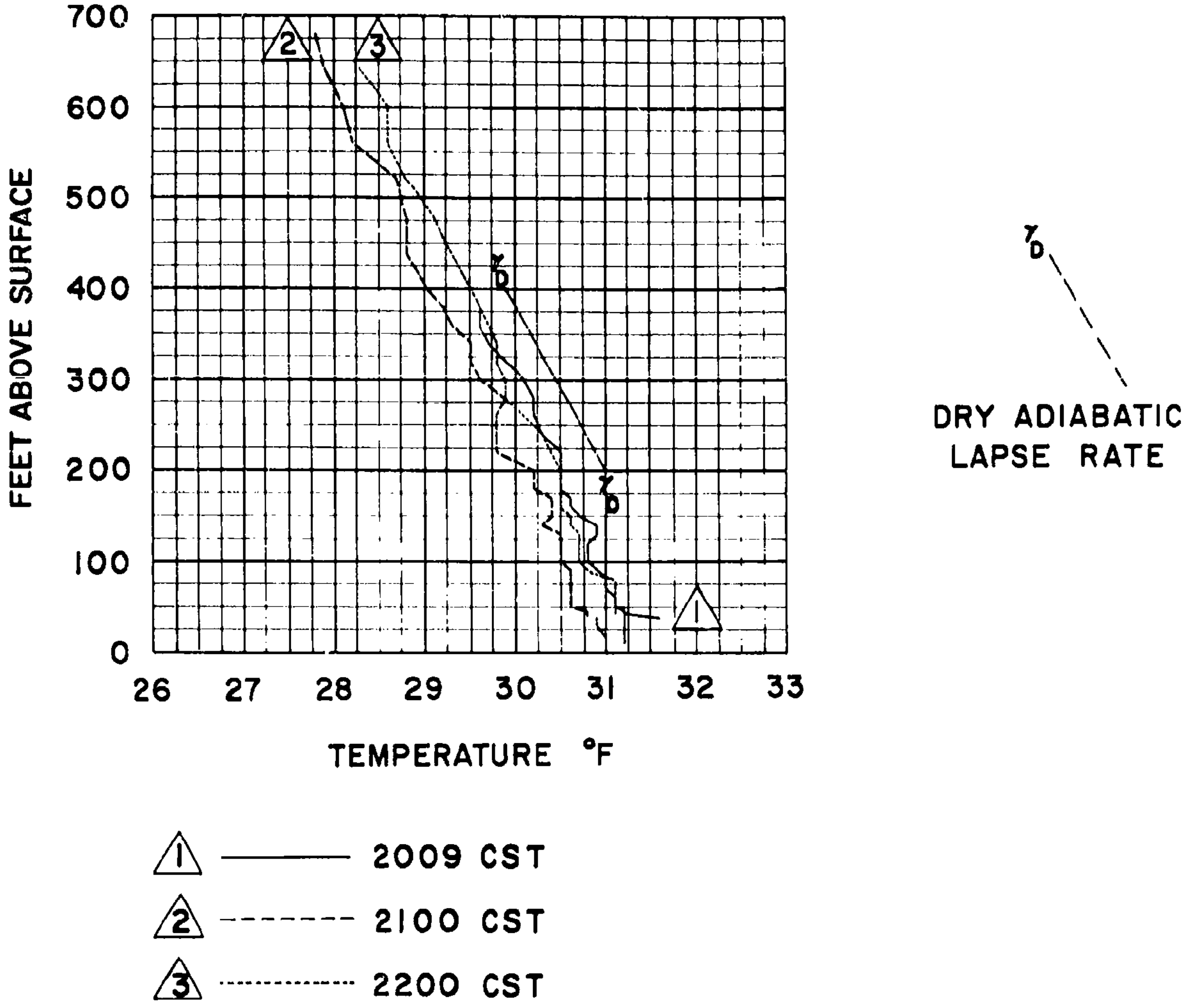


FIGURE B-9
TEMPERATURE SOUNDINGS
MINNEAPOLIS RESIDENTIAL
WIRESONDE
SURVEY M-36 21 JAN. 1953

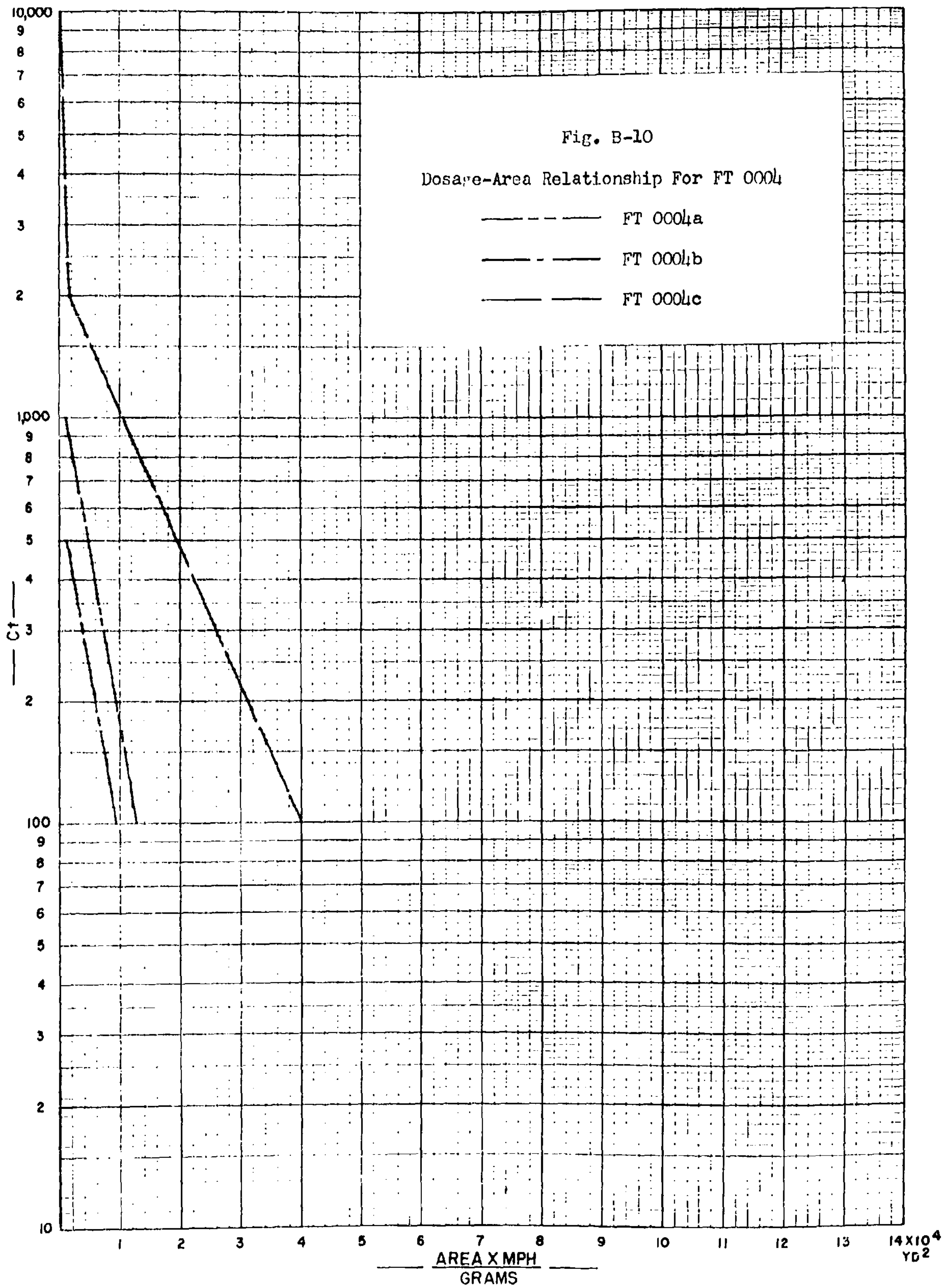


Fig. B-10
Dosage-Area Relationship For FT 0004
FT 0004a
FT 0004b
FT 0004c
Ct
10,000
1,000
100
10
1 2 3 4 5 6 7 8 9 10 11 12 13 14X10^4 YD^2
AREA X MPH
GRAMS

AEROSOL GENERATION

Point-source release of 5.8 gms of NJZ 2266 over a period of 5 minutes starting at 2010 CST from a vehicle-mounted blower disperser located at point ✠ .

SAMPLING

Location and Exposure

Membrane-filter sampling equipment located at 52 stations as shown on test-array map by following symbols:

● Outdoor sampler at height between 1 and 6 feet.

◒ Outdoor sampler at height above or below general terrain level as indicated by note.

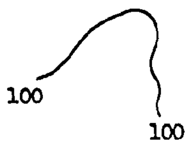
○ Indoor sampler at location indicated by test-array map or text.

Results

All samplers operated to measure total dosages.

● 58 Total Dosage (particle-minutes per liter)

T = trace dosage
M = malfunction or data missing



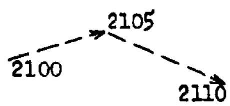
Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

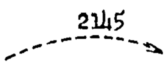
Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as M1 and M2 .

Similar observations at rooftop level (35 feet above surface, at SW corner of the school building) and wiresonde ascents made at meteorological station M3 .



Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between the times indicated.



Balloon track representing wind-drift observation at the time indicated.

Winds

Roof-level winds easterly at 4.5 mph; street-level winds easterly at 2.0 mph.

Stability

1.1° F lapse from 6-300 ft.

Sky

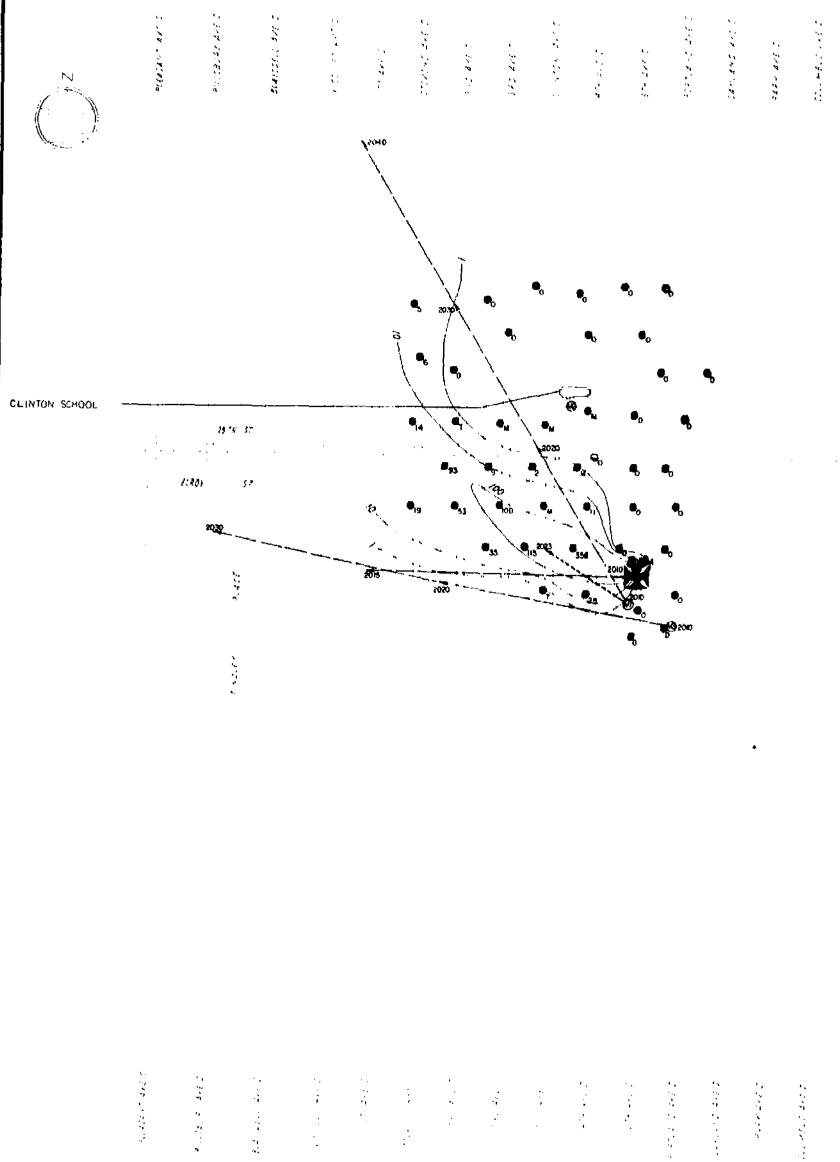
The low overcast at 1930 CST, with base near 1500 ft above surface, became broken at 2030 CST, then scattered at 2130 CST. A broken-to-overcast middle cloud deck with base 7,000 to 9,000 ft above the surface persisted throughout the sampling period.

Temperature

31° F at 2 meters in the test area.

Moisture

Mixing ratio of 3.4 gm/kgm dry air.



LOOKING NORTH FROM LOCATION
OF AEROSOL GENERATION

SECRET
SECURITY INFORMATION

FIGURE B-11
TEST ARRAY AND RESULTS
FT 0004a 2010 CST
JANUARY 21, 1953

AEROSOL GENERATION

Point-source release of 6.7 gms of NJZ 2266 over a period of 5 minutes starting at 2123 CST from a vehicle-mounted blower disperser located at point ✠ .

SAMPLING

Location and Exposure

Membrane-filter sampling equipment located at 52 stations as shown on test-array map by following symbols:

● Outdoor sampler at height between 1 and 6 feet.

◓ Outdoor sampler at height above or below general terrain level as indicated by note.

○ Indoor sampler at location indicated by test-array map or text.

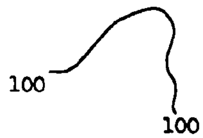
Results

All samplers operated to measure total dosages.

Total Dosage (particle-minutes per liter)

● 58

T = trace dosage
M = malfunction or data missing



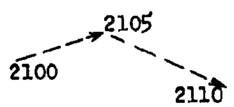
Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

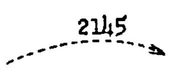
Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as M1 and M2 .

Similar observations at rooftop level (35 feet above surface, at SW corner of the school building) and wiresonde ascents made at meteorological station M3 .



Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between the times indicated.



Balloon track representing wind-drift observation at the time indicated.

Winds

Roof-level winds easterly at 4.5 mph; street-level winds easterly at 0.9 mph.

Stability

1.2° F lapse from 6-300 ft.

Sky

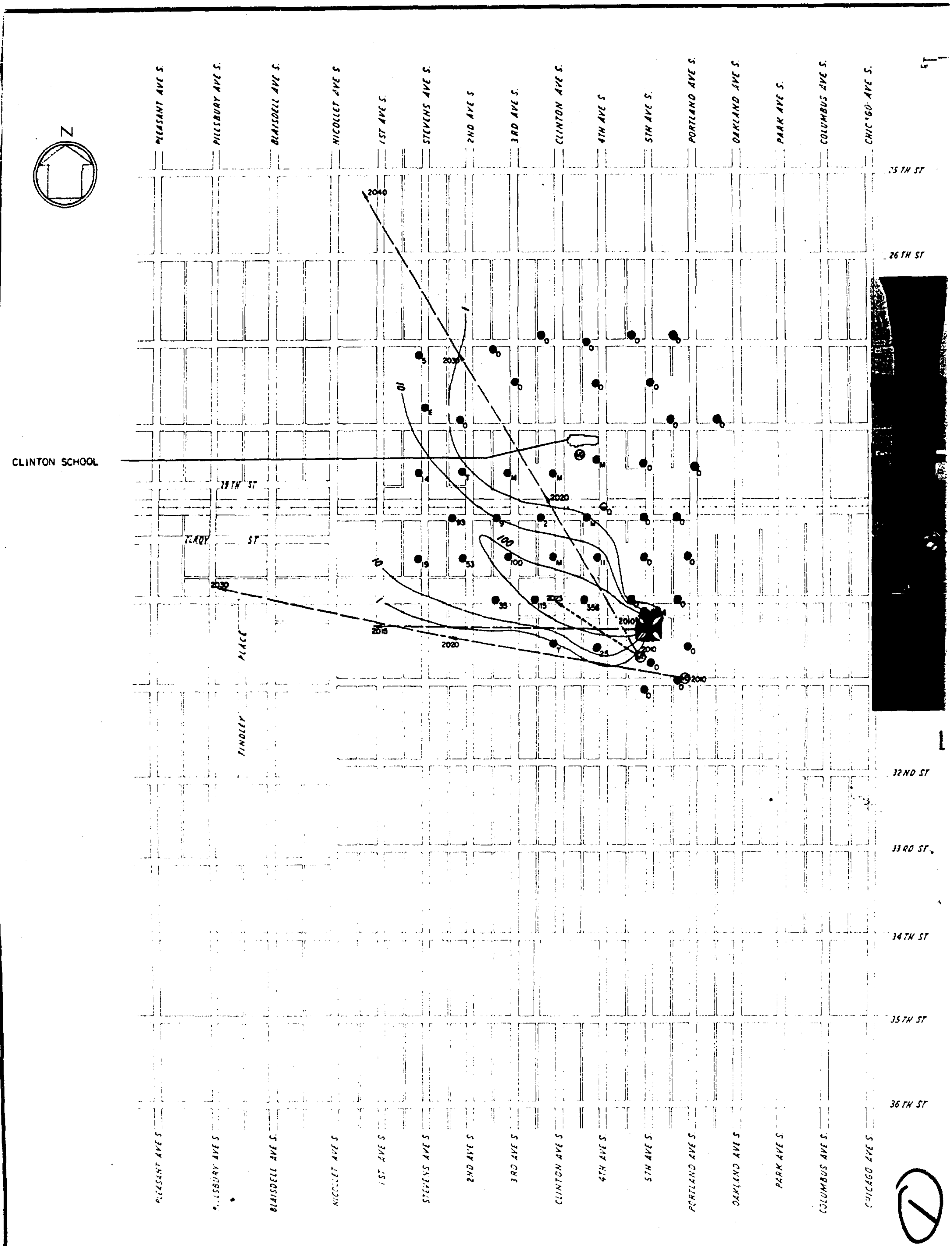
The low overcast at 1930 CST, with base near 1500 ft above surface, became broken at 2030 CST, then scattered at 2130 CST. A broken-to-overcast middle cloud deck with base 7,000 to 9,000 ft above the surface persisted throughout the sampling period.

Temperature

31° F at 2 meters in the test area.

Moisture

Mixing ratio of 3.4 gm/kgm dry air.


N
CLINTON SCHOOL
PLEASANT AVE S.
PILLSBURY AVE S.
BLAISDELL AVE S.
NICOLLET AVE S.
1ST AVE S.
STEVENS AVE S.
2ND AVE S.
3RD AVE S.
CLINTON AVE S.
4TH AVE S
5TH AVE S.
PORTLAND AVE S.
OAKLAND AVE S.
PARK AVE S.
COLUMBUS AVE S.
CHICAGO AVE S.
25TH ST
26TH ST
29TH ST
32ND ST
33RD ST
34TH ST
35TH ST
36TH ST
FINDLEY PLACE
2040
2030
2020
2010
2015
100
10
1

LOOKING NORTH FROM LOCATION
OF AEROSOL GENERATION

SECRET
SECURITY INFORMATION

2

FIGURE B-11
TEST ARRAY AND RESULTS
FT 0004a 2010 CST
JANUARY 21, 1953

AEROSOL GENERATION

Point-source release of 9.1 gms of NJZ 2266 over a period of 5 minutes starting at 2243 CST from a vehicle-mounted blower disperser located at point ✠ .

SAMPLING

Location and Exposure

Membrane-filter sampling equipment located at 52 stations as shown on test-array map by following symbols:

● Outdoor sampler at height between 1 and 6 feet.

◒ Outdoor sampler at height above or below general terrain level as indicated by note.

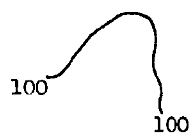
○ Indoor sampler at location indicated by test-array map or text.

Results

All samplers operated to measure total dosages.

● 58 — Total Dosage (particle-minutes per liter)

T = trace dosage
M = malfunction or data missing



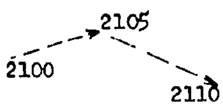
Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

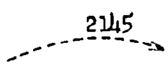
Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as M1 and M2 .

Similar observations at rooftop level (35 feet above surface, at SW corner of the school building) and wiresonde ascents made at meteorological station M3 .



Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between the times indicated.



Balloon track representing wind-drift observation at the time indicated.

Winds

Roof-level winds easterly at 7.5 mph; street-level winds easterly at 1.0 mph.

Stability

1.1° F lapse from 6-300 ft.

Sky

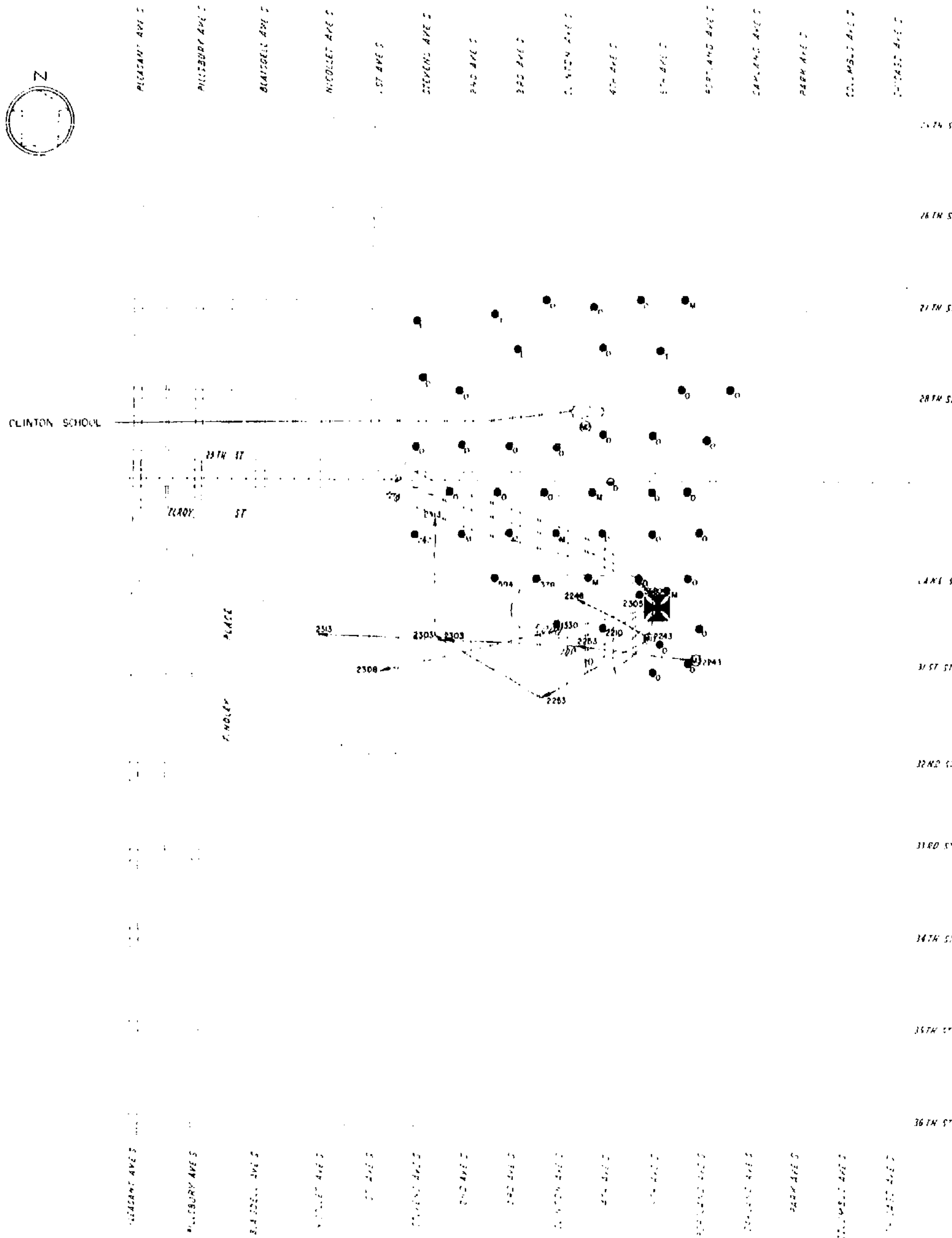
The low overcast at 1930 CST, with base near 1500 ft above surface, became broken at 2030 CST, then scattered at 2130 CST. A broken-to-overcast middle cloud deck with base 7,000 to 9,000 ft above the surface persisted throughout the sampling period.

Temperature

31° F at 2 meters in the test area.

Moisture

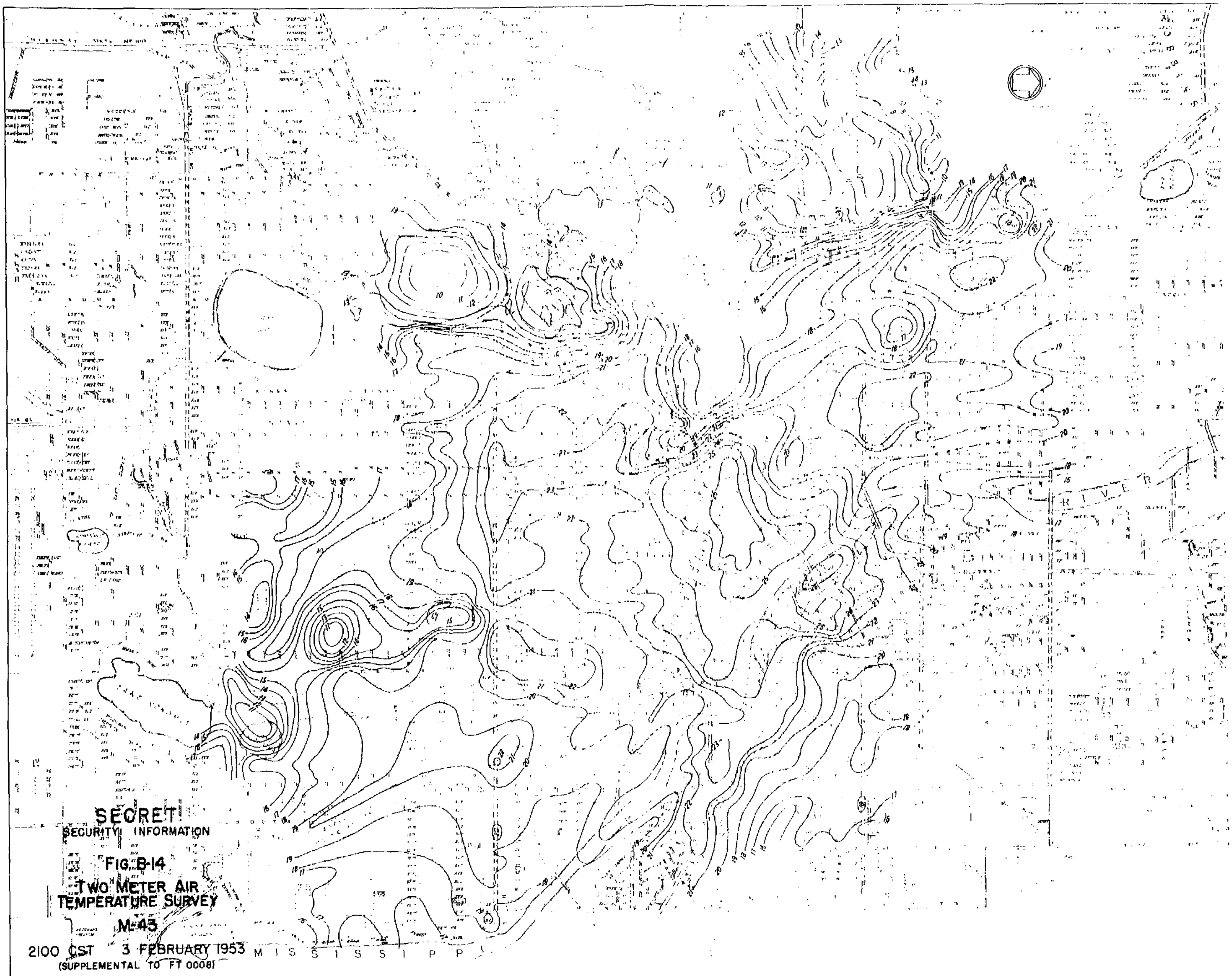
Mixing ratio of 3.4 gm/kgm dry air.



LOOKING NORTH FROM LOCATION
OF AEROSOL GENERATION

SECRET
SECURITY INFORMATION

FIGURE B-13
TEST ARRAY AND RESULTS
FT 0004c 2243 CST
JANUARY 21, 1953



SECRET
SECURITY INFORMATION

FIG. B-14
TWO METER AIR TEMPERATURE SURVEY
M-43
2100 CST 3 FEBRUARY 1953
(SUPPLEMENTAL TO FT 0008)

SUMMARY OF REGIONAL AND LOCAL WEATHER

FT 0008 Survey M-43 3 Feb 1953

Synoptic Situation

A cold front had passed Minneapolis on the previous day leaving $2\frac{1}{2}$ inches of fresh snow. A warm front was located about 300 miles to the west. A 1011 mb low cell was located north of the Great Lakes. A weak high cell with pressure 1021 mb was centered over northwestern Illinois. Surface wind flow was southeasterly 2 to 5 mph. Air flow at 700 mb was from the west-northwest at 30 mph.

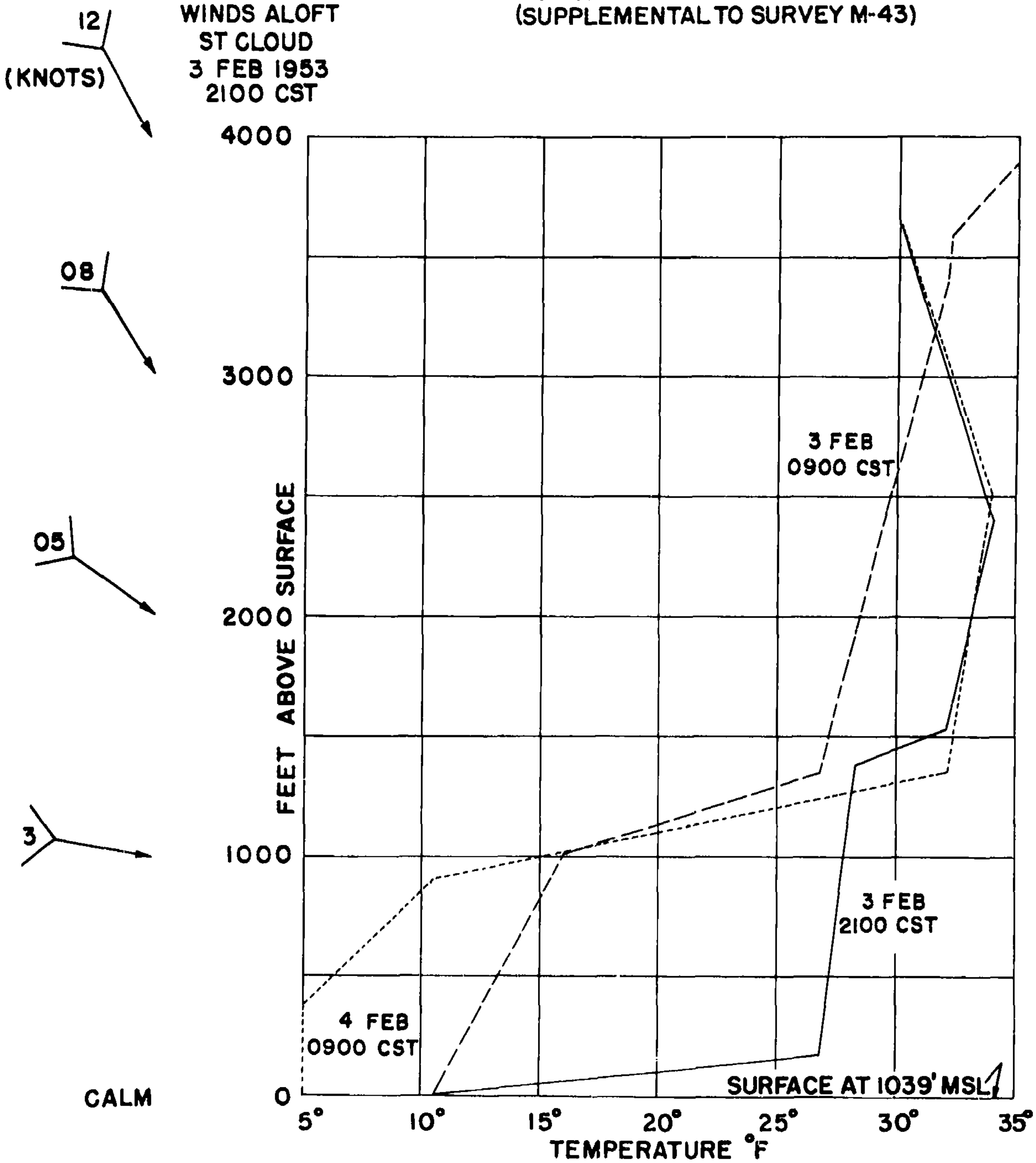
Weather reports from Wold-Chamberlain Field (Minneapolis)

Time CST	Cloud Height (feet)	Sky* Cover	Visibility (miles)	Weather**	Temp (^{o}F)	Dew Point	Wind Dir	Wind Speed (mph)
1830		Clear	12		27	22	S	3
1930		Clear	12		24	21	ESE	5
2030		Clear	12		22	19	SE	4
2130		Clear	7		21	18	SSE	5
2230		Clear	$2\frac{1}{2}$	Ground Fog	20	18	SE	4
2330		Clear	$1\frac{1}{2}$	Ground Fog	18	17	S	2
0030		Obs-cured	$\frac{1}{4}$	Ice Fog	16	14	SSE	3

Sea level pressure at 2130 CST: 1017.6
Ground condition: 3" packed snow Side streets slippery Lakes were frozen
Tree cover: none
* Average cloudiness sunrise to sunset: 80%
** and/or restrictions to visibility

FIGURE B-15

TEMPERATURE SOUNDINGS
ST CLOUD RAOB 3 FEB 1953
(SUPPLEMENTAL TO SURVEY M-43)



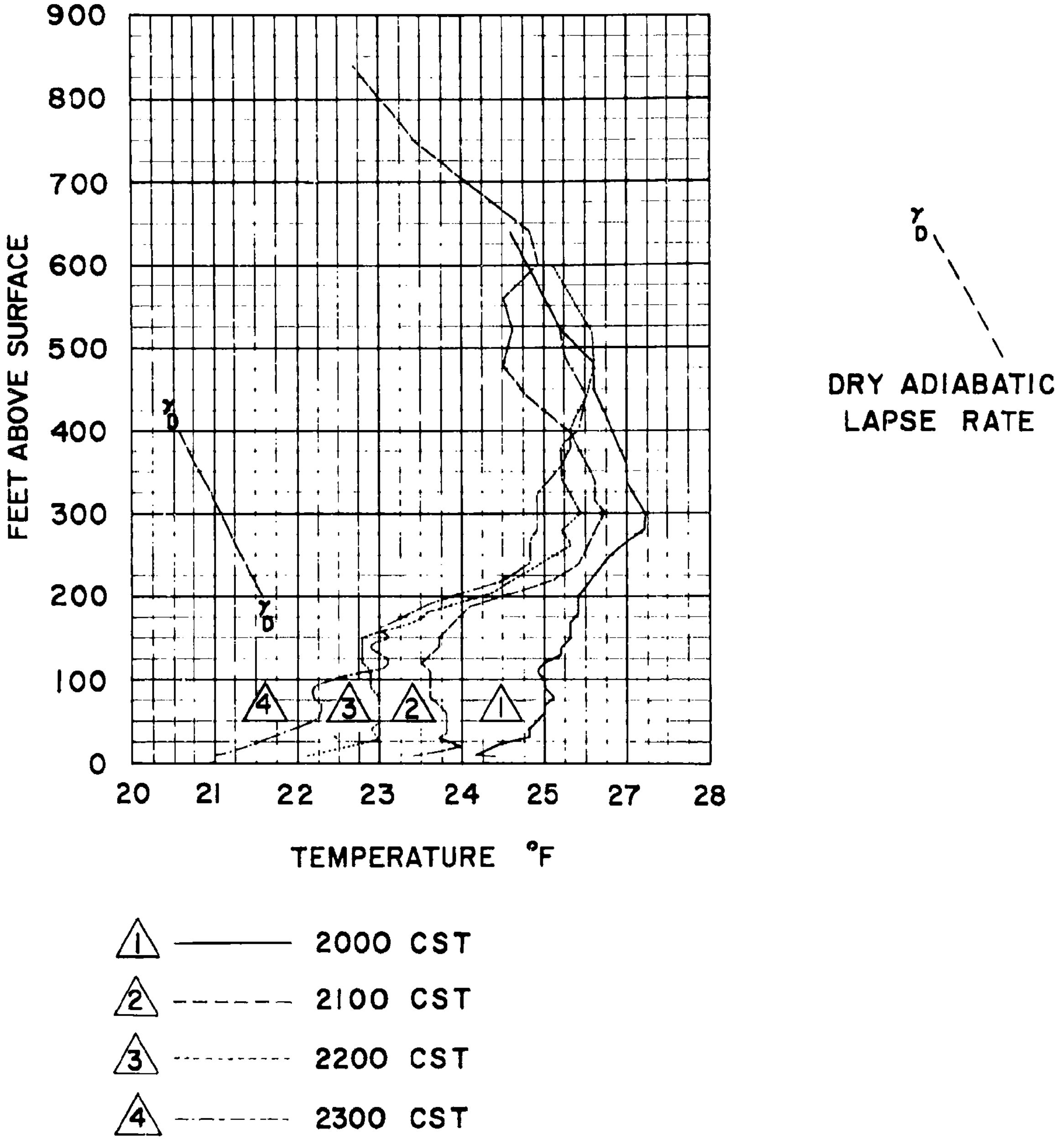


FIGURE B-16
TEMPERATURE SOUNDINGS
MINNEAPOLIS RESIDENTIAL
WIRESONDE
SURVEY M-43 3 FEB. 1953

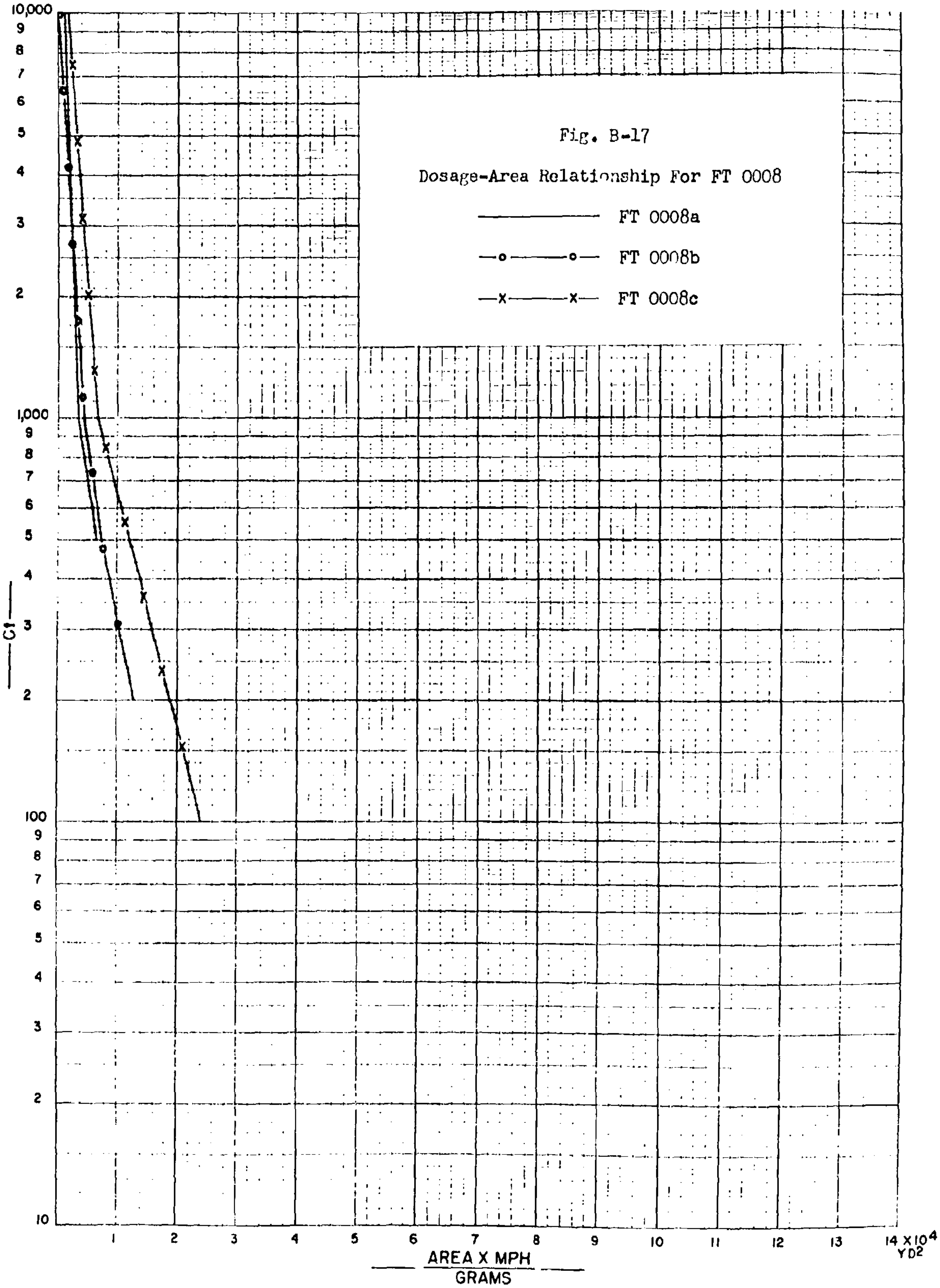


Fig. B-17
Dosage-Area Relationship For FT 0008
FT 0008a
FT 0008b
FT 0008c
10,000
1,000
100
10
Ct
1
2
3
4
5
6
7
8
9
10
11
12
13
14 X10^4
YD^2
AREA X MPH
GRAMS

SUMMARY OF HOUSE-PENETRATION AND CLINTON SCHOOL DOSAGES*
FT 0008a 3 February 1953

RESIDENCES**

House	Outside	Basement	First Floor	Second Floor
A	15 8	0 T	T 0	0 0

CLINTON SCHOOL***

	Ground	Ground Floor	First Floor	Second Floor	Roof
Outside	T T		0 T	0 0	0 0
					0
Inside		0 T	0 0	0 0	
		0		0	
		0			

* Dosages are expressed in particle-minutes per liter; T represents trace dosage, i.e., a count not exceeding 15 fluorescent particles. When more than one sampler is involved, values are listed on separate lines. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units.

** Individual residences are described in Section V-E. With the illustration of a given house (see Figs. V-23 through V-27) is given the summary of all dosages obtained at that house.

*** The sampler array for this and other tests is found in Figs. V-28 through V-31.

AEROSOL GENERATION

Point-source release of 8.1 gms of NJZ 2266 over a period of 5 minutes starting at 2006 CST from a vehicle-mounted blower disperser located at point ✠.

SAMPLING

Location and Exposure

Membrane-filter sampling equipment located at 92 stations as shown on test-array map by following symbols:

● Outdoor sampler at height between 1 and 6 feet.

◒ Outdoor sampler at height above or below general terrain level as indicated by note.

○ Indoor sampler at location indicated by test-array map or text.

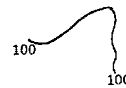
Results

All samplers operated to measure total dosages. In addition, samplers at selected stations were operated incrementally, as shown by the sampling period and the corresponding increment dosage given to the left of the station symbol.

Sampling Period	Increment Dosage	Total Dosage (particle-minutes per liter)
2000-2045 CST	50	● 58
2100-2115 CST	8	

T = trace dosage
M = malfunction or data missing

Since sampling period was not continuous, the actual total dosage in some cases is probably more than indicated.



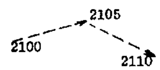
Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

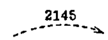
Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as M1 and M2.

Similar observations at rooftop level (36 feet above surface, at SW corner of school building) and wiresonde ascents made at meteorological station M3.



Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between the times indicated.



Balloon track representing wind-drift observation at the indicated time.

Winds

Roof-level winds east-southeasterly at 0.5 mph; street-level winds southeasterly at 1.0 mph.

Stability

1.8° F inversion from 6-300 ft.

Sky

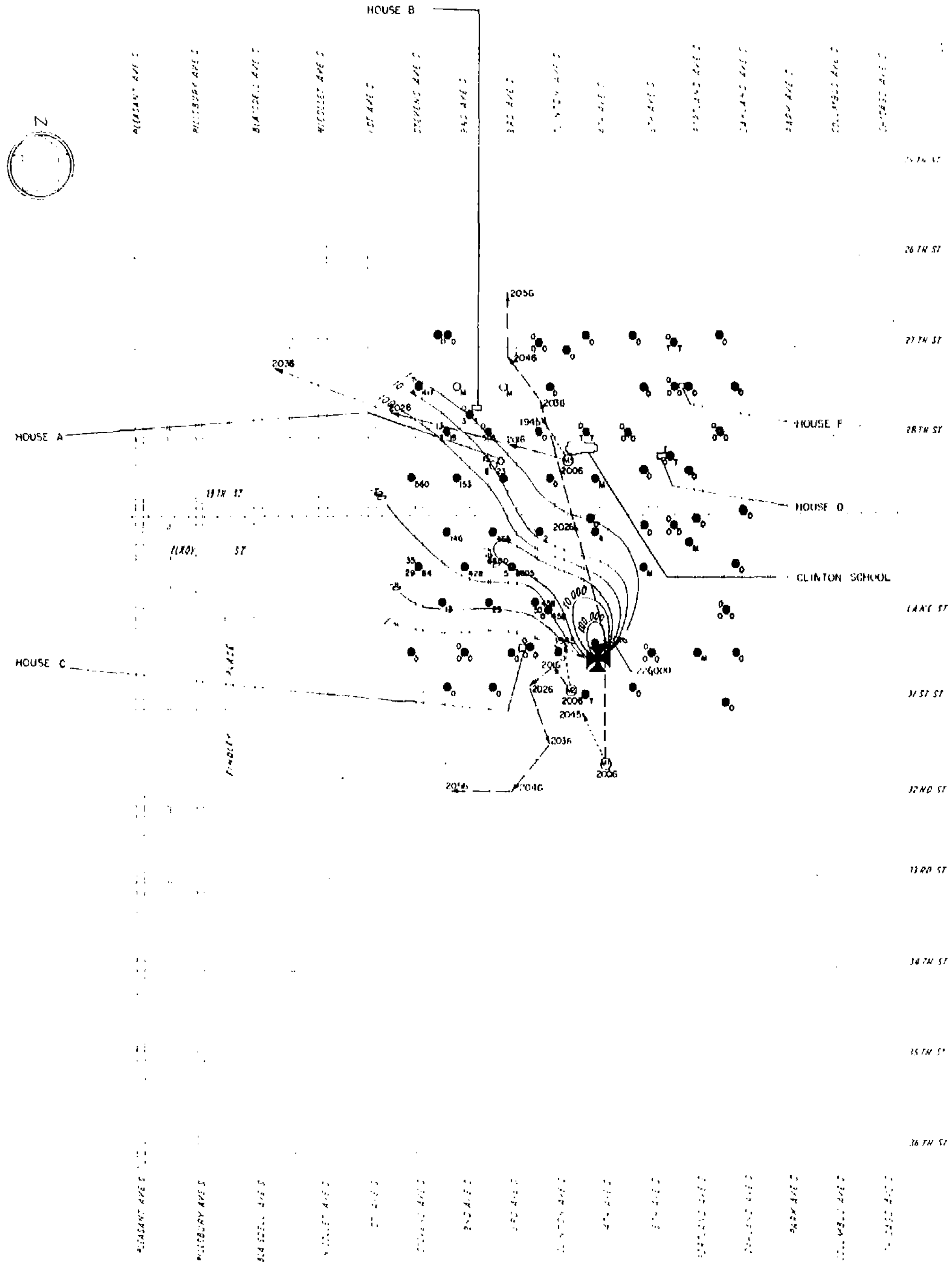
Clear; ground fog, which was forming about 2200 CST, changed to ice fog and obscured sky from view at approximately 0000 CST.

Temperature

21-24° F at 2 meters in the test area.

Moisture

Mixing ratio of 2.1 gm/kgm dry air.



LOOKING NORTH FROM LOCATION
OF AEROSOL GENERATION

SECRET
SECURITY INFORMATION

FIGURE B-18
TEST ARRAY AND RESULTS
FT 0008a 2006 CST
FEBRUARY 3, 1953

SUMMARY OF HOUSE-PENETRATION AND CLINTON SCHOOL DOSAGES*
FT 0008b 3 February 1953

RESIDENCES**

House	Outside	Basement	First Floor	Second Floor
A	26 152		3 17	0 3
B	17 110	3 31	3 5	0 3
C	4410 390	1000 493	141 160	83 117

CLINTON SCHOOL***

	Ground	Ground Floor	First Floor	Second Floor	Roof
Outside	50 104		22 89	14 40	27 50
					33
Inside		T	3 14	0 8	
		0		16	
		0 33			

* Dosages are expressed in particle-minutes per liter; T represents trace dosage, i.e., a count not exceeding 15 fluorescent particles. When more than one sampler is involved, values are listed on separate lines. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units.

** Individual residences are described in Section V-E. With the illustration of a given house (see Figs. V-23 through V-27) is given the summary of all dosages obtained at that house.

*** The sampler array for this and other tests is found in Figs. V-28 through V-31.

AEROSOL GENERATION

Point-source release of 5.0 gms of NJZ 2266 over a period of 5 minutes starting at 2134 CST from a vehicle-mounted blower disperser located at point ✠.

SAMPLING

Location and Exposure

Membrane-filter sampling equipment located at 92 stations as shown on test-array map by following symbols:

● Outdoor sampler at height between 1 and 6 feet.

◒ Outdoor sampler at height above or below general terrain level as indicated by note.

○ Indoor sampler at location indicated by test-array map or text.

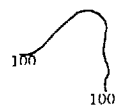
Results

All samplers operated to measure total dosages. In addition, samplers at selected stations were operated incrementally, as shown by the sampling period and the corresponding increment dosage given to the left of the station symbol.

Sampling Period	Increment Dosage	Total Dosage (particle-minutes per liter)
2130-2215 CST	50	● 58
2230-2245 CST	8	

T = trace dosage
M = malfunction or data missing

Since sampling period was not continuous, the actual total dosage in some cases is probably more than indicated.



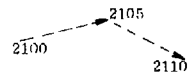
Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

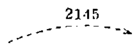
Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as M1 and M2.

Similar observations at rooftop level (35 feet above surface, at SW corner of the school building) and wiresonde ascents made at meteorological station M3.



Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between the times indicated.



Balloon track representing wind-drift observation at the time indicated.

Winds

Roof-level winds east-southerly at 1.2 mph; street-level winds southerly at 0.5 mph.

Stability

3.0° F inversion from 6-300 ft.

Sky

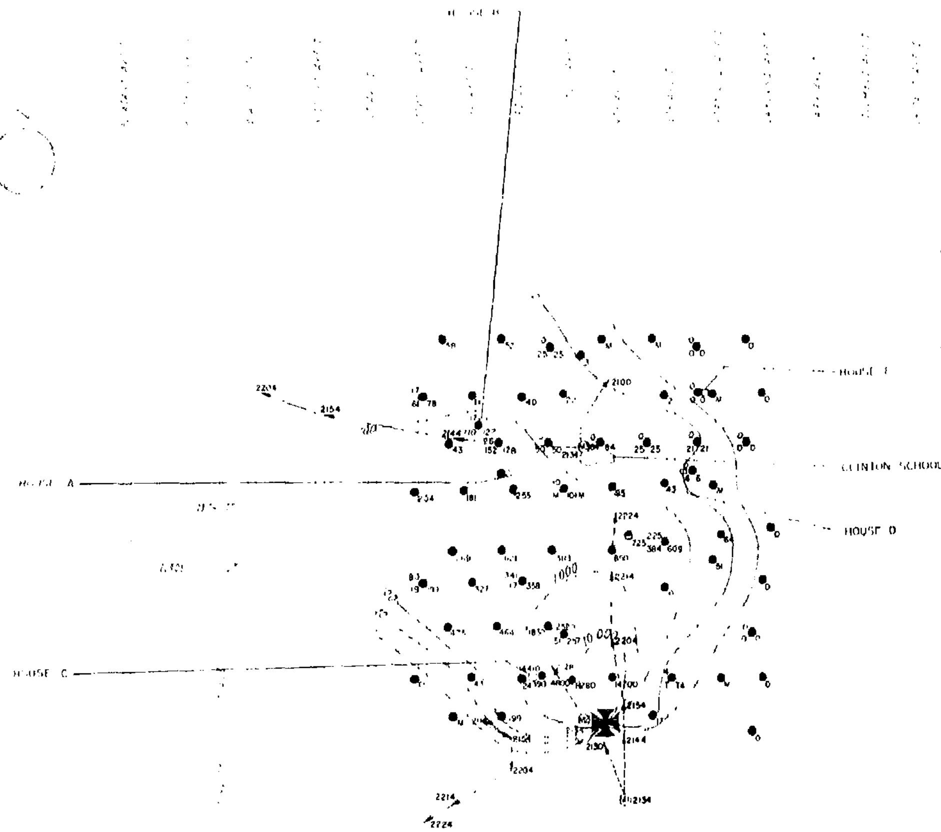
Clear; ground fog, which was forming about 2200 CST, changed to ice fog and obscured sky from view at approximately 0000 CST.

Temperature

21-24° F at 2 meters in the test area.

Moisture

Mixing ratio of 2.1 gm/kgm dry air.



LOOKING NORTH ALONG FOURTH AVENUE FROM LOCATION OF AEROSOL GENERATION

SECRET
SECURITY INFORMATION

FIGURE B-19
TEST ARRAY AND RESULTS
FT 0008b 2134 CST
FEBRUARY 3, 1953

SUMMARY OF CLINTON SCHOOL DOSAGES*
FT 0008c**   3 February 1953

	Ground	Ground Floor	First Floor	Second Floor	Roof
Outside	110 7		51 T	50 T	50 T
					59
Inside		15 3	19 12	16 8	
		33		43	
		35			

* Dosages are expressed in particle-minutes per liter; T represents trace dosage, i.e., a count not exceeding 15 fluorescent particles. When more than one sampler is involved, values are listed on separate lines. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units.

** The sampler array for this and other tests is found in Figs. V-28 through V-31.

AEROSOL GENERATION

Point-source release of 7.4 gms of NJZ 2266 over a period of 5 minutes starting at 2304 CST from a vehicle-mounted blower disperser located at point ✠ .

SAMPLING

Location and Exposure

Membrane-filter sampling equipment located at 92 stations as shown on test-array map by following symbols:

● Outdoor sampler at height between 1 and 6 feet.

◒ Outdoor sampler at height above or below general terrain level as indicated by note.

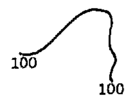
○ Indoor sampler at location indicated by test-array map or text.

Results

All samplers operated to measure total dosages. In addition, samplers at selected stations were operated incrementally, as shown by the sampling period and the corresponding increment dosage given to the left of the station symbol.

Sampling period	Increment Dosage	Total Dosage (particle-minutes per liter)
2300-2345 CST	50	T = trace dosage
2400-0015 CST	8 ● 58	M = malfunction or data missing

Since sampling period was not continuous, the actual total dosage in some cases is probably more than indicated.



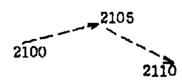
Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

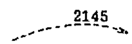
Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as (M1) and (M2) .

Similar observations at rooftop level (35 feet above surface, at SW corner of the school building) and wiresonde ascents made at meteorological station (M3) .



Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between the times indicated.



Balloon track representing wind-drift observation at the time indicated.

Winds

Roof-level winds southeasterly at 1.9 mph; street-level winds southerly at 0.5 mph.

Stability

3.8° F inversion from 6-300 ft.

Sky

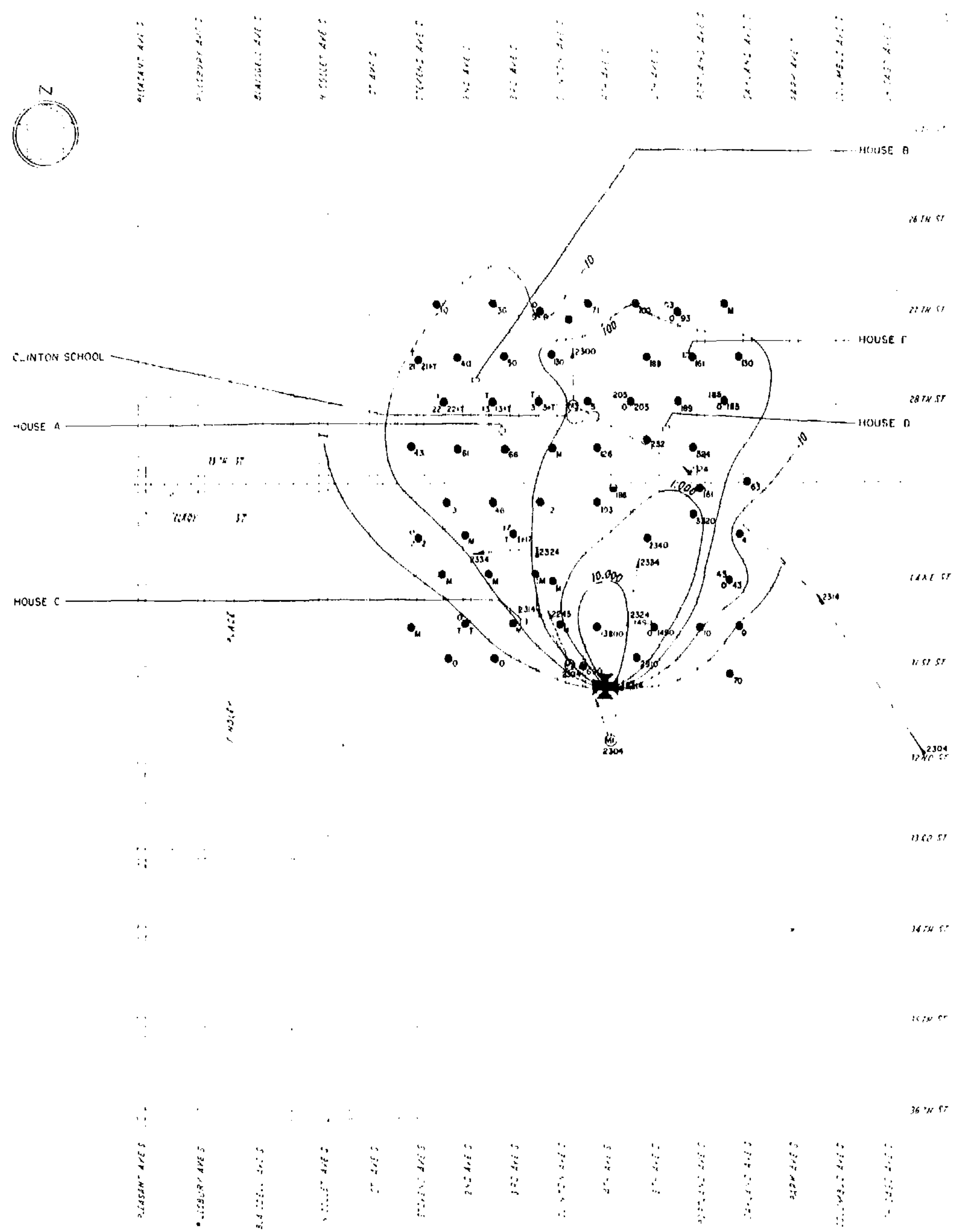
Clear; ground fog, which was forming about 2200 CST, changed to ice fog and obscured sky from view at approximately 0000 CST.

Temperature

21-24° F at 2 meters in the test area.

Moisture

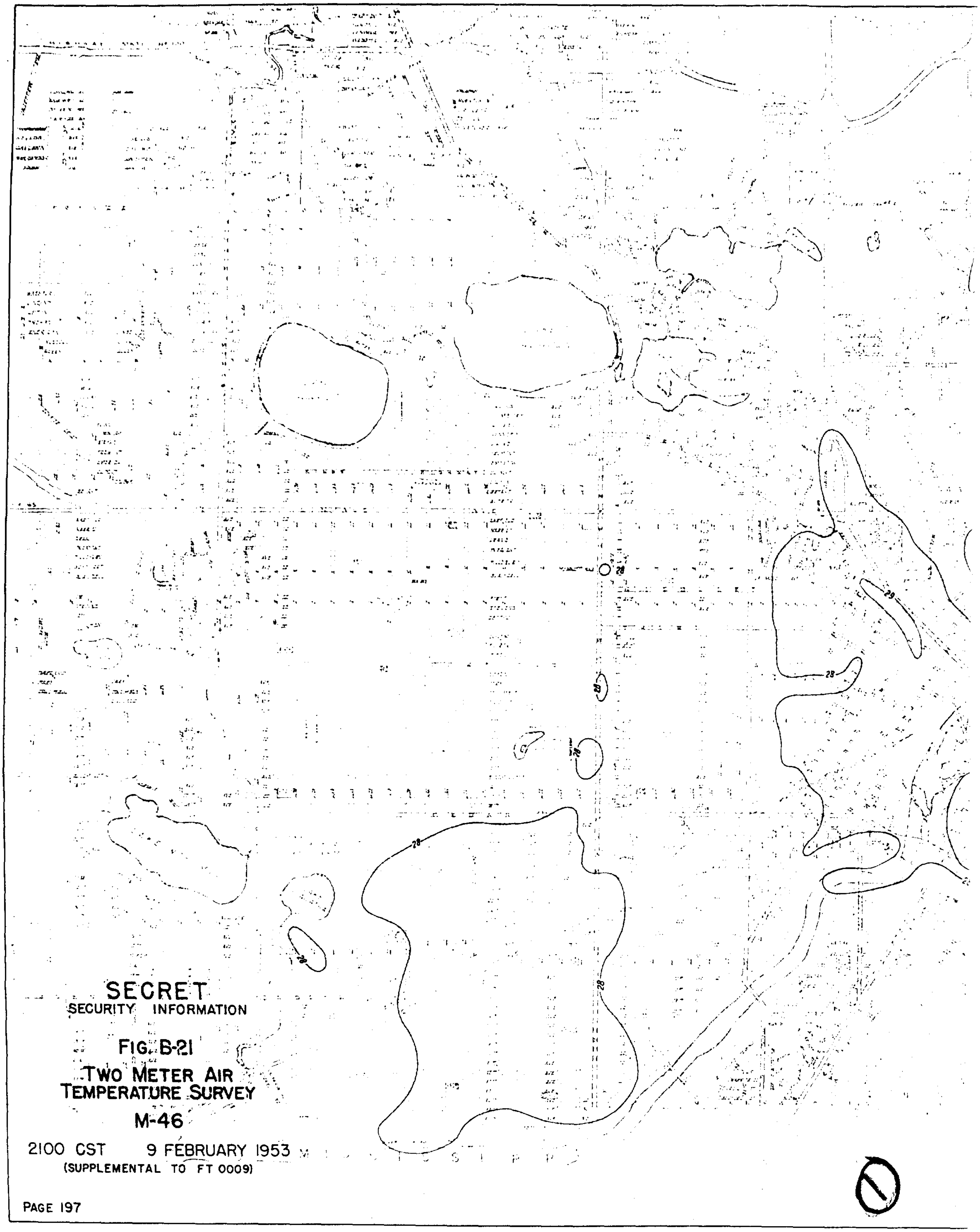
Mixing ratio of 2.1 gm/kgm dry air.



LOOKING NORTH ALONG FOURTH AVENUE FROM LOCATION OF AEROSOL GENERATION

SECRET
SECURITY INFORMATION

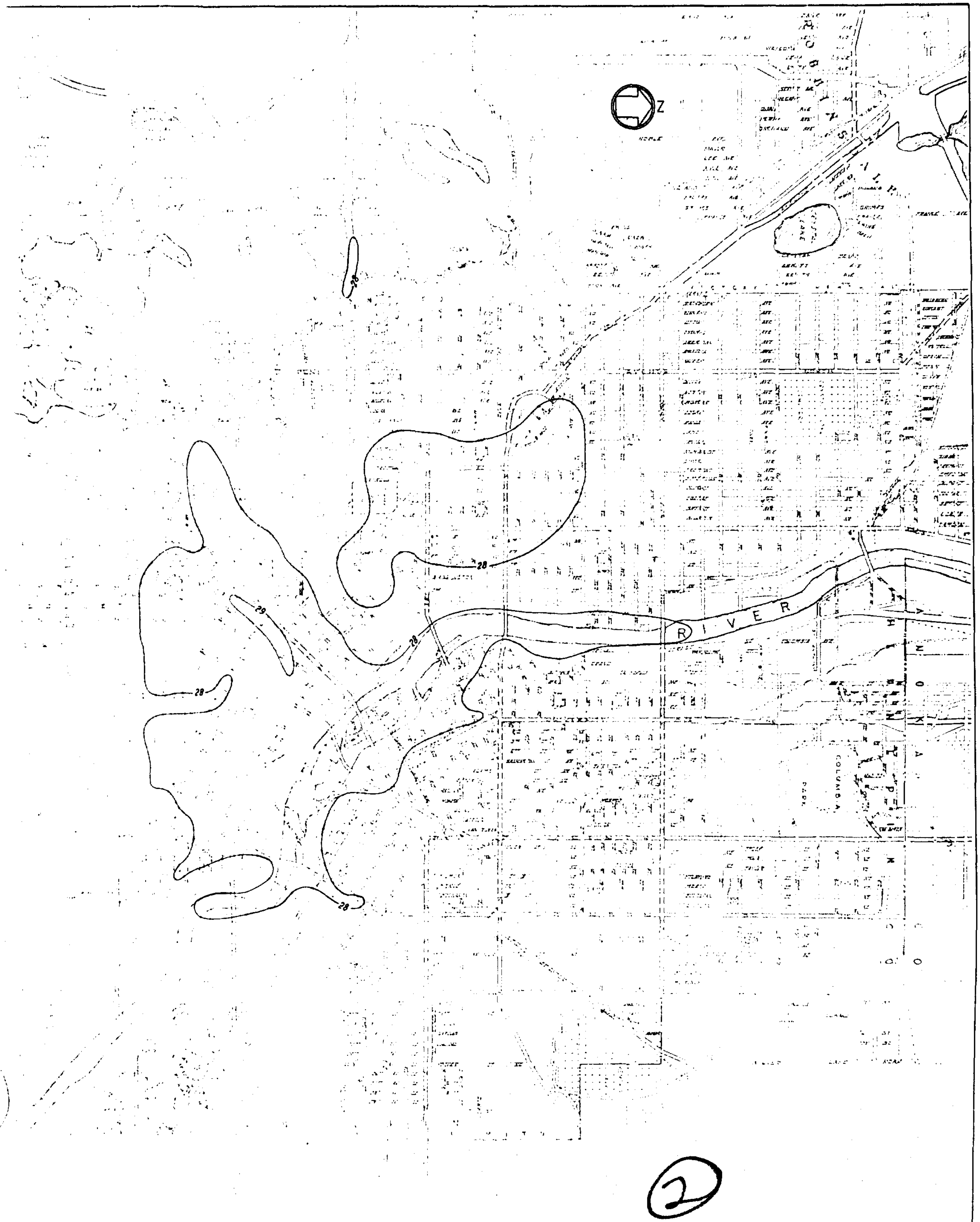
FIGURE B-20
TEST ARRAY AND RESULTS
FT 0008c 2304 CST
FEBRUARY 3, 1953



SECRET
SECURITY INFORMATION

FIG. B-21
TWO METER AIR TEMPERATURE SURVEY
M-46

2100 CST 9 FEBRUARY 1953
(SUPPLEMENTAL TO FT 0009)



(2)

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SUMMARY OF REGIONAL AND LOCAL WEATHER

FT 0009 Survey M-46 9 Feb 1953

Synoptic Situation

A warm front through southern Iowa associated with a 1019 mb low center near Omaha was moving toward Minneapolis. Light snow was occurring far ahead of this system and reached Minneapolis at the end of the test. A 1046 mb high was located over 300 miles northeast of International Falls. Surface wind flow was easterly 18 mph. Air flow at the 700 mb level was south-southwesterly at 42 mph.

Weather reports from Wold-Chamberlain Field (Minneapolis)

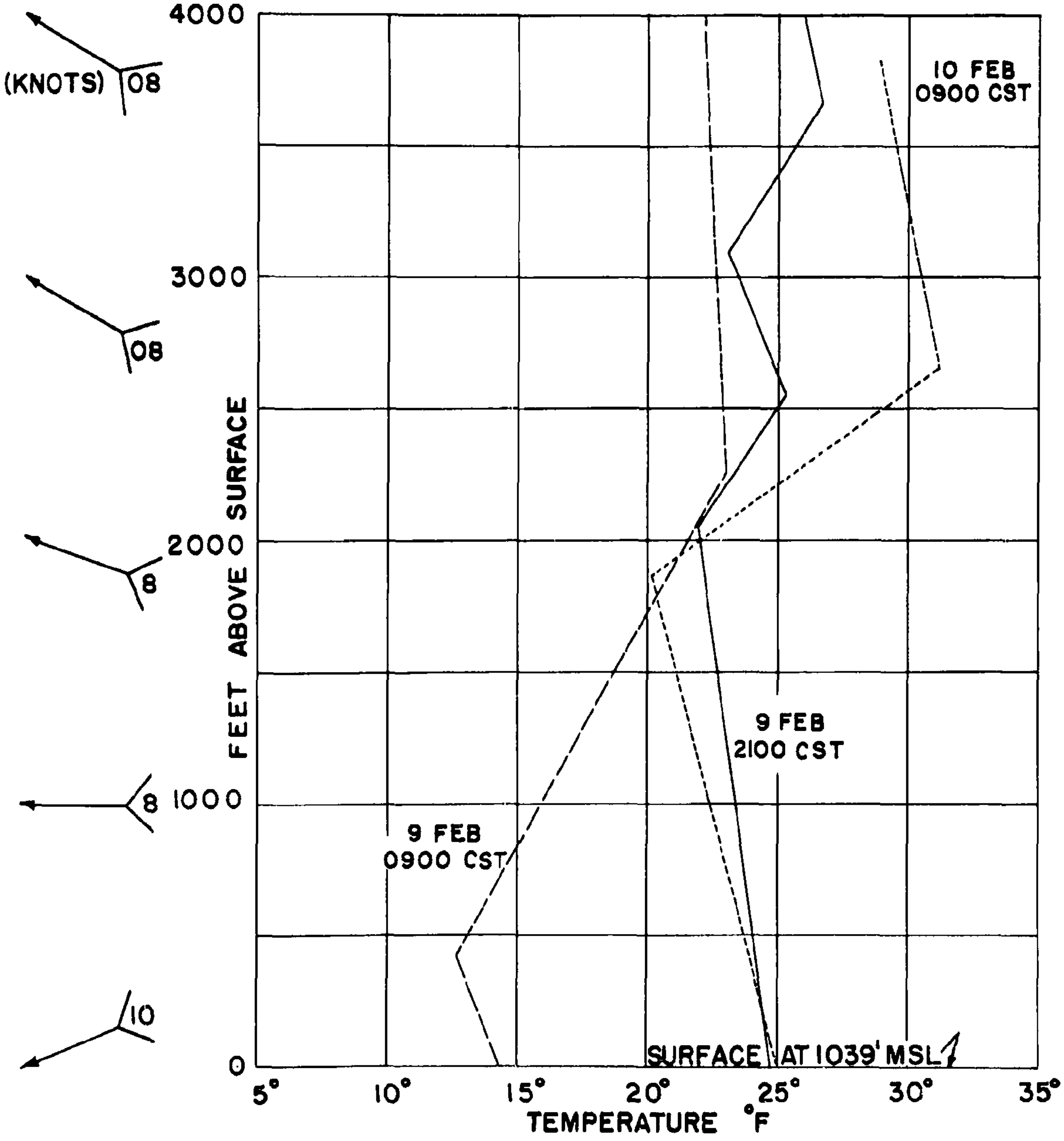
Time CST	Cloud Height (feet)	Sky* Cover	Visibility (miles)	Weather**	Temp (°F)	Dew Point	Wind Dir	Wind Speed (mph)
1830	3800	Broken	15	None	26	16	ENE	14
1930	4000	Scattered	15	None	26	16	ENE	16
2030	4000	Scattered	15	None	27	18	ENE	17
2130	3600	Overcast	15	None	27	17	E	18
2230	3600	Overcast	15	Light Snow	27	19	E	18
2330	4000	Overcast	15	None	28	18	E	19
0030	2200	Obscured	3	Light Snow	27	18	E	23

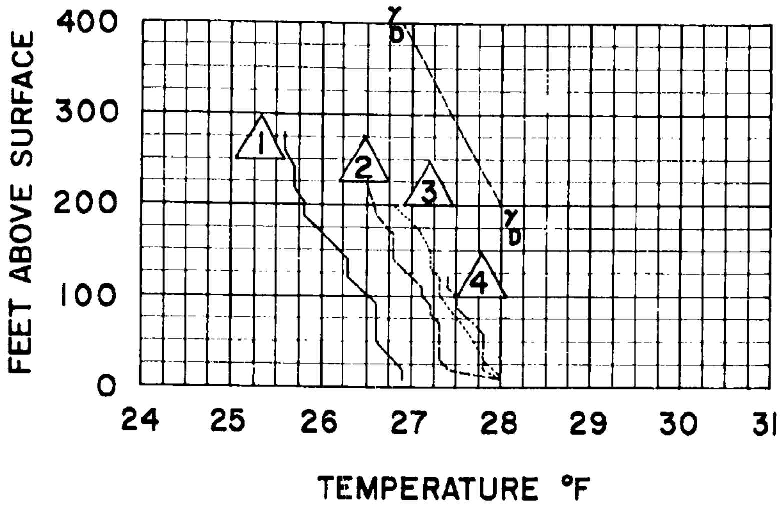
Sea level pressure at 2130 CST: 1033.2 mb
Ground condition: 3" to 4" packed snow Main streets clear Secondary Streets 2" packed snow and ice Lakes were frozen
Tree cover: None
* Average cloudiness sunrise to sunset: 100%
** and/or restrictions to visibility

FIGURE B-22

TEMPERATURE SOUNDINGS
ST CLOUD RAOB 9 FEB 1953
(SUPPLEMENTAL TO SURVEY M-46)

WINDS ALOFT
ST CLOUD
9 FEB 1953
2100 CST





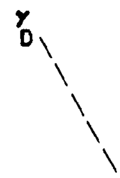


FIGURE B-23
TEMPERATURE SOUNDINGS
MINNEAPOLIS RESIDENTIAL
WIRESONDE
SURVEY M-46 9 FEB. 1953

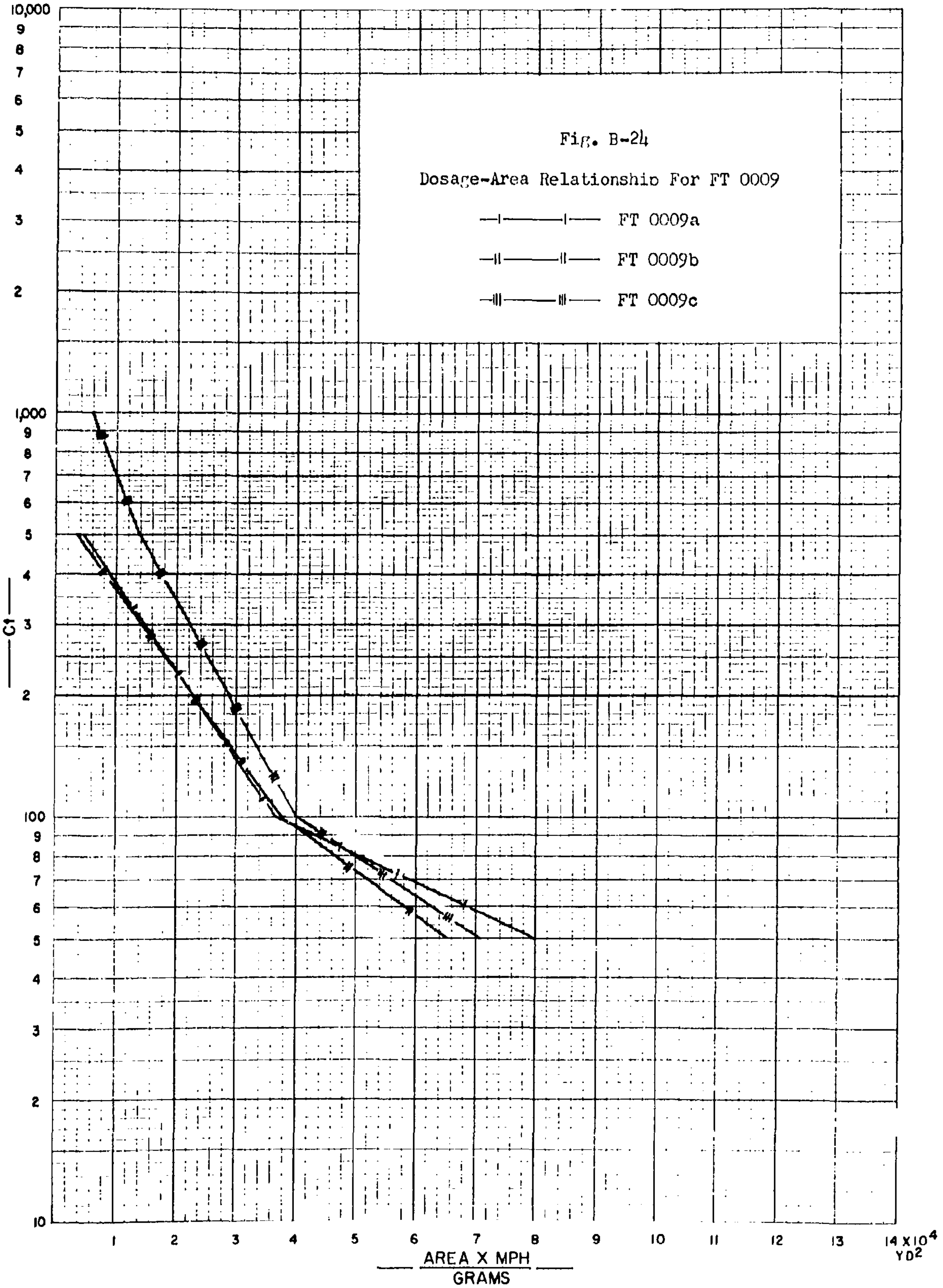


Fig. B-24
Dosage-Area Relationship For FT 0009
FT 0009a
FT 0009b
FT 0009c
10,000
9
8
7
6
5
4
3
2
1,000
100
10
Ct
1
2
3
4
5
6
7
8
9
10
11
12
13
14 X 10^4
YD^2
AREA X MPH
GRAMS

SUMMARY OF HOUSE-PENETRATION AND CLINTON SCHOOL DOSAGES*
FT 0009a 9 February 1953

RESIDENCES**

House	Outside	Basement	First Floor	Second Floor
D	79 0	12 2	13 9	
		5 5		

CLINTON SCHOOL***

	Ground	Ground Floor	First Floor	Second Floor	Roof
Outside	11 0		9 0	11 0	2 0
					4 0
Inside		0 2	2 T	0 0	
		0 T		T 0	
		0 0			

* Dosages are expressed in particle-minutes per liter; T represents trace dosage, i.e., a count not exceeding 15 fluorescent particles. When more than one sampler is involved, values are listed on separate lines. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units.

** Individual residences are described in Section V-E. With the illustration of a given house (see Figs. V-23 through V-27) is given the summary of all dosages obtained at that house.

*** The sampler array for this and other tests is found in Figs. V-28 through V-31.

AEROSOL GENERATION

Point-source release of 12.2 gms of NJZ 2266 over a period of 5 minutes starting at 2017 CST from a vehicle-mounted blower disperser at point ✠ .

SAMPLING

Location and Exposure

Membrane-filter sampling equipment located at 93 stations as shown on test-array map by following symbols:

● Outdoor sampler at height between 1 and 6 feet.

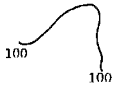
◒ Outdoor sampler at height above or below general terrain level as indicated by note.

○ Indoor sampler at location indicated by test-array map or text.

Results

All samplers operated to measure total dosages. In addition, samplers at selected stations were operated incrementally, as shown by the sampling period and the corresponding increment dosage given to the left of the station symbol.

Sampling Period	Increment Dosage		Total Dosage (particle-minutes per liter)
2000-2045 CST	50		T = trace dosage
2045-2115 CST	8	● 58	M = malfunction or data missing



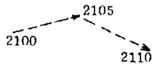
Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

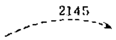
Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as M1 and M2 .

Similar observations attempted at rooftop level (35 feet above surface, at NE corner of school building) and wiresonde ascents made at meteorological station M3 . (No wind data obtained because of recorder malfunction.)



Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between the times indicated.



Balloon track representing wind-drift observation at the time indicated.

Winds

Winds at treetop level estimated northeast to easterly at 15-20 mph; street-level winds northeasterly at 5 mph.

Stability

1.4° F lapse from 6-300 ft.

Sky

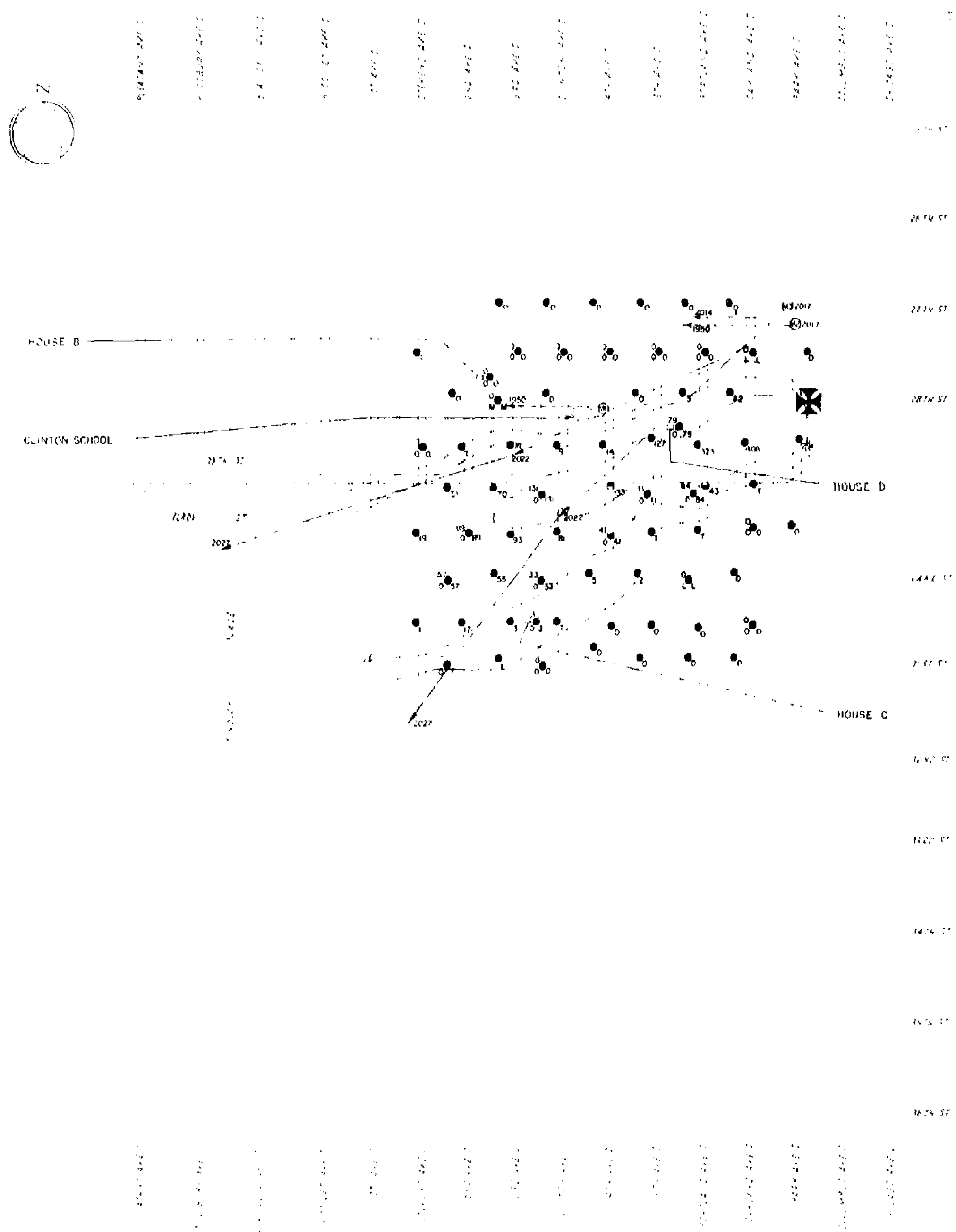
Low scattered clouds at 2000 CST, with base about 4000 ft. above the surface, became overcast at 2130 CST. A middle deck with bases 9,000 to 11,000 ft. above the surface persisted throughout the test period.

Temperature

27-28° F at 2 meters in the test area.

Moisture

Mixing ratio of 2.1 gm/kgm dry air.



LOOKING WEST FROM LOCATION
OF AEROSOL GENERATION

SECRET
SECURITY INFORMATION

FIGURE B-25
TEST ARRAY AND RESULTS
FT 0009a 2017 CST
FEBRUARY 9, 1953

SUMMARY OF HOUSE-PENETRATION AND CLINTON SCHOOL DOSAGES*
FT 0009b — 9 February 1953

RESIDENCES**

House	Outside	Basement	First Floor	Second Floor
D	395 T	31 10	52 13	
		39 8		

CLINTON SCHOOL***

	Ground	Ground Floor	First Floor	Second Floor	Roof
Outside	136 2		128 0	60 0	112 0
				143 0	135 0
Inside		4 2	24 5	13 7	
		16 6			
		13 9			

* Dosages are expressed in particle-minutes per liter; T represents trace dosage, i.e., a count not exceeding 15 fluorescent particles. When more than one sampler is involved, values are listed on separate lines. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units.

** Individual residences are described in Section V-E. With the illustration of a given house (see Figs. V-23 through V-27) is given the summary of all dosages obtained at that house.

*** The sampler array for this and other tests is found in Figs. V-28 through V-31.

AEROSOL GENERATION

Point-source release of 12.3 gms of NJZ 2266 over a period of 5 minutes starting at 2135 CST from a roof-mounted blower disperser (35 ft. above street level) located at point ✠.

SAMPLING

Location and Exposure

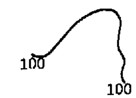
Membrane-filter sampling equipment located at 93 stations as shown on test-array map by following symbols:

- ● Outdoor sampler at height between 1 and 6 feet.
- ◒ Outdoor sampler at height above or below general terrain level as indicated by note.
- ○ Indoor sampler at location indicated by test-array map or text.

Results

All samplers operated to measure total dosages. In addition, samplers at selected stations were operated incrementally, as shown by the sampling period and the corresponding increment dosage given to the left of the station symbol.

Sampling Period	Increment Dosage		Total Dosage (particle-minutes per liter)
2130-2215 CST	50	● 58	T = trace dosage
2215-2245 CST	8		M = malfunction or data missing



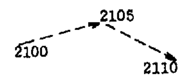
Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

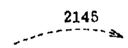
Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as (M1) and (M2).

Similar observations attempted at rooftop level (35 feet above surface, at NE corner of school building) and wiresonde ascents made at meteorological station (M3). (No wind data obtained because of recorder malfunction.)



Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between times indicated.



Balloon track representing wind-drift observation at the time indicated.

Winds

Winds at treetop level estimated northeast to easterly at 15-20 mph; street-level winds northeasterly at 5 mph.

Stability

1.9° F lapse from 6-300 feet.

Sky

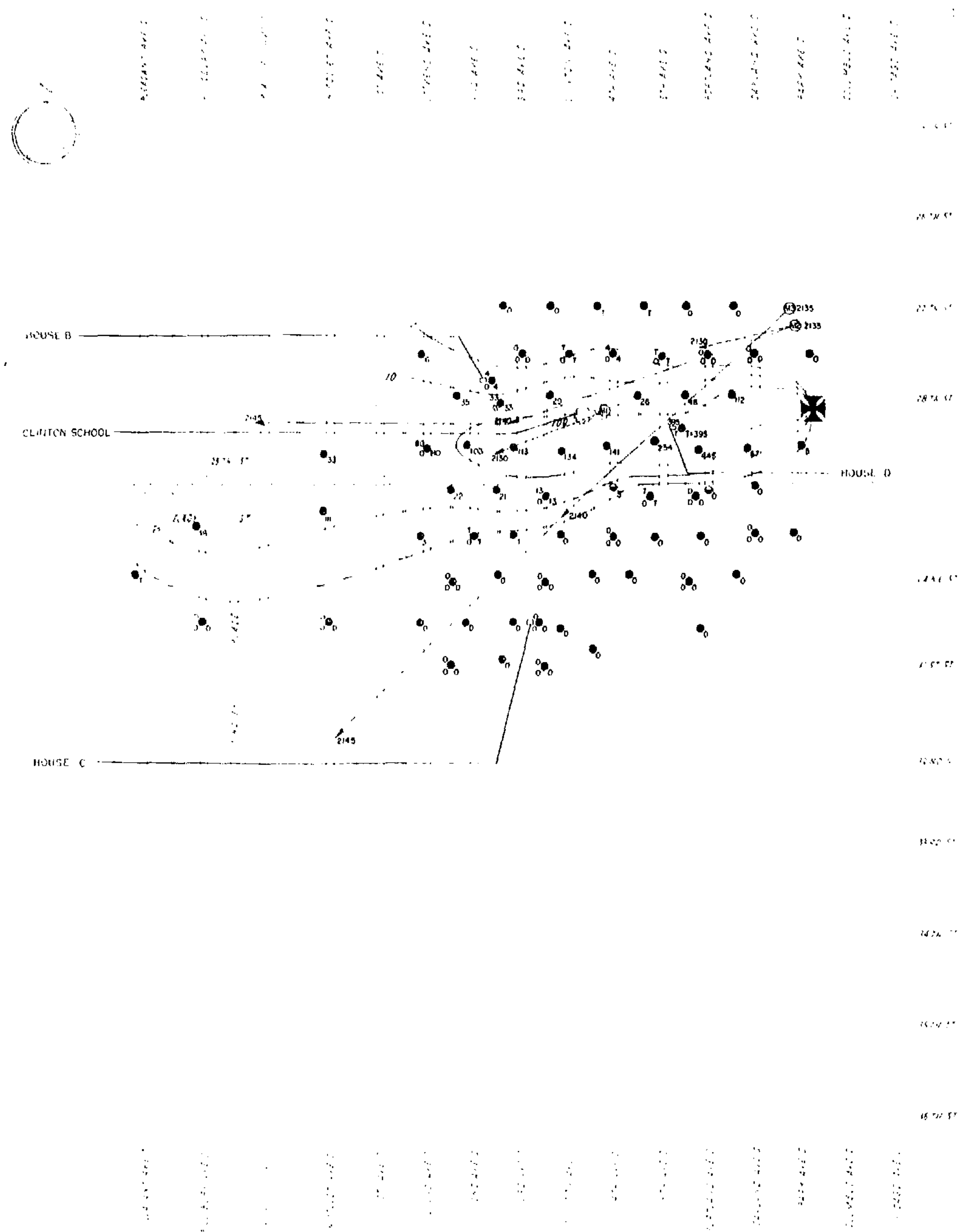
Low scattered clouds at 2000 CST, with base about 4000 ft. above the surface, became overcast at 2130 CST. A middle deck with bases 9,000 to 11,000 ft. above the surface persisted throughout the test period.

Temperature

27-28° F at 2 meters in the test area.

Moisture

Mixing ratio of 2.1 gm/kgm dry air.



LOOKING WEST FROM ROOF TOP LOCATION
OF AEROSOL GENERATION

SECRET
SECURITY INFORMATION

FIGURE B-26
TEST ARRAY AND RESULTS
FT 0009b 2135 CST
FEBRUARY 9, 1953

SUMMARY OF CLINTON SCHOOL DOSAGES*
FT 0009c**   9 February 1953

	Ground	Ground Floor	First Floor	Second Floor	Roof
Outside	117 0		136 T	202 0	191 0
				132 0	318 0
Inside		34 12	25 7	29 13	
		6 6			
		35 26			

* Dosages are expressed in particle-minutes per liter; T represents trace dosage, i.e., a count not exceeding 15 fluorescent particles. When more than one sampler is involved, values are listed on separate lines. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units.

** The sampler array for this and other tests is found in Figs. V-28 through V-31.

AEROSOL GENERATION

Point-source release of 12.0 gms of NJZ 2266 over a period of 5 minutes starting at 2305 CST from a vehicle-mounted blower disperser located at point ✠ .

SAMPLING

Location and Exposure

Membrane-filter sampling equipment located at 93 stations as shown on test-array map by following symbols:

- ● Outdoor sampler at height between 1 and 6 feet.
- ◒ Outdoor sampler at height above or below general terrain level as indicated by note.
- ○ Indoor sampler at location indicated by test-array map or text.

Results

All samplers operated to measure total dosages. In addition, samplers at selected stations were operated incrementally, as shown by the sampling period and the corresponding increment dosage given to the left of the station symbol.

Sampling Period	Increment Dosage		Total Dosage (particle-minutes per liter)
2300-2345 CST	50	● 58	T = trace dosage
2345-0015 CST	8		M = malfunction or data missing

100 100 Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as M1 and M2 .

Similar observations at rooftop level (35 feet above surface, at NE corner of school building) and wiresonde ascents made at meteorological station M3 .

2100 2105 2110 Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between indicated times.

2145 Balloon track representing wind-drift observation at the time indicated.

Winds

Roof-level winds northeasterly at 10 mph; street-level winds east-northeasterly at 6.5 mph.

Stability

1.9° F lapse from 6-300 ft.

Sky

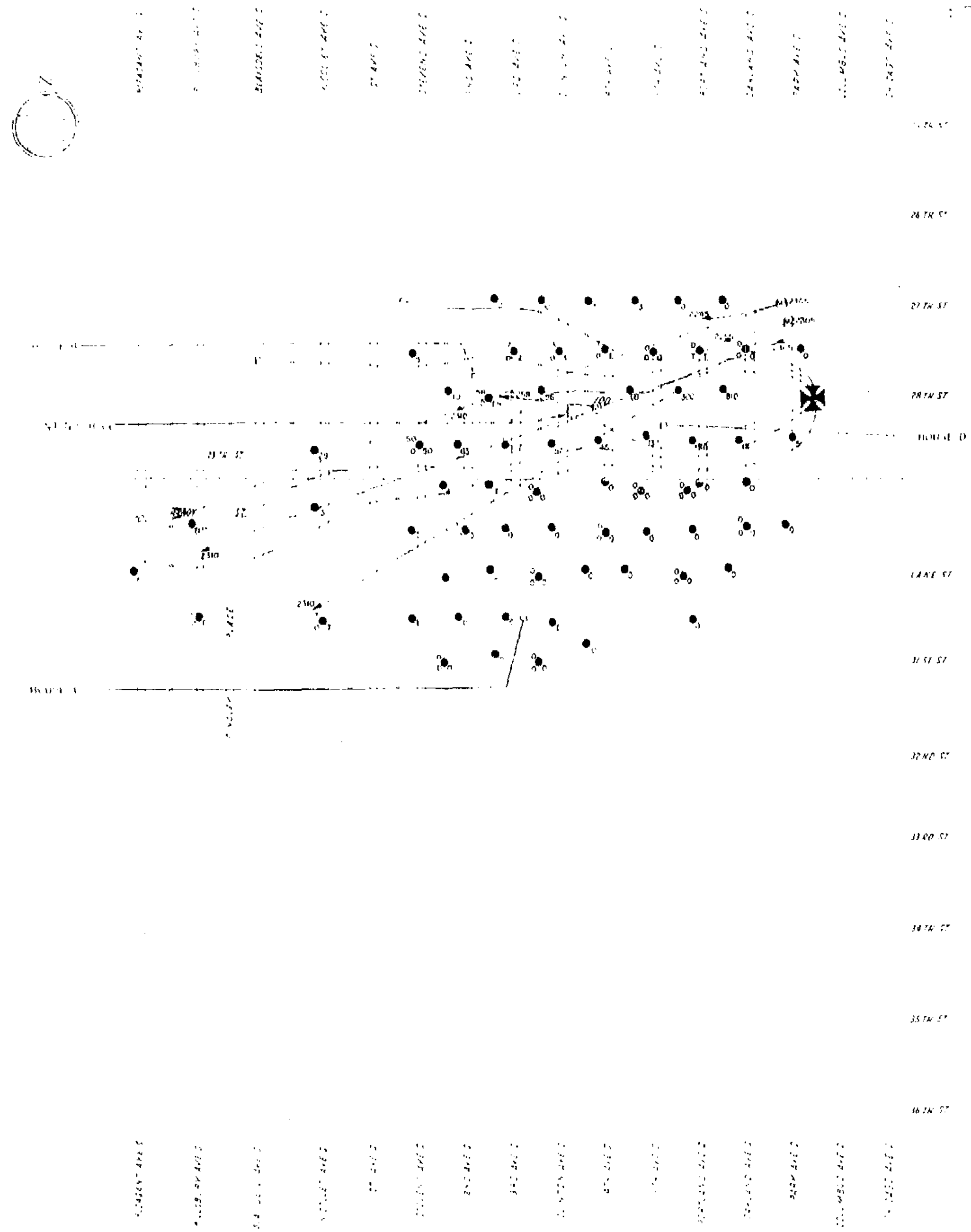
Low scattered clouds at 2000 CST, with base about 4000 ft. above the surface, became overcast at 2130 CST. A middle deck with bases 9,000 to 11,000 ft. above the surface persisted throughout the test period.

Temperature

27-28° F at 2 meters in the test area.

Moisture

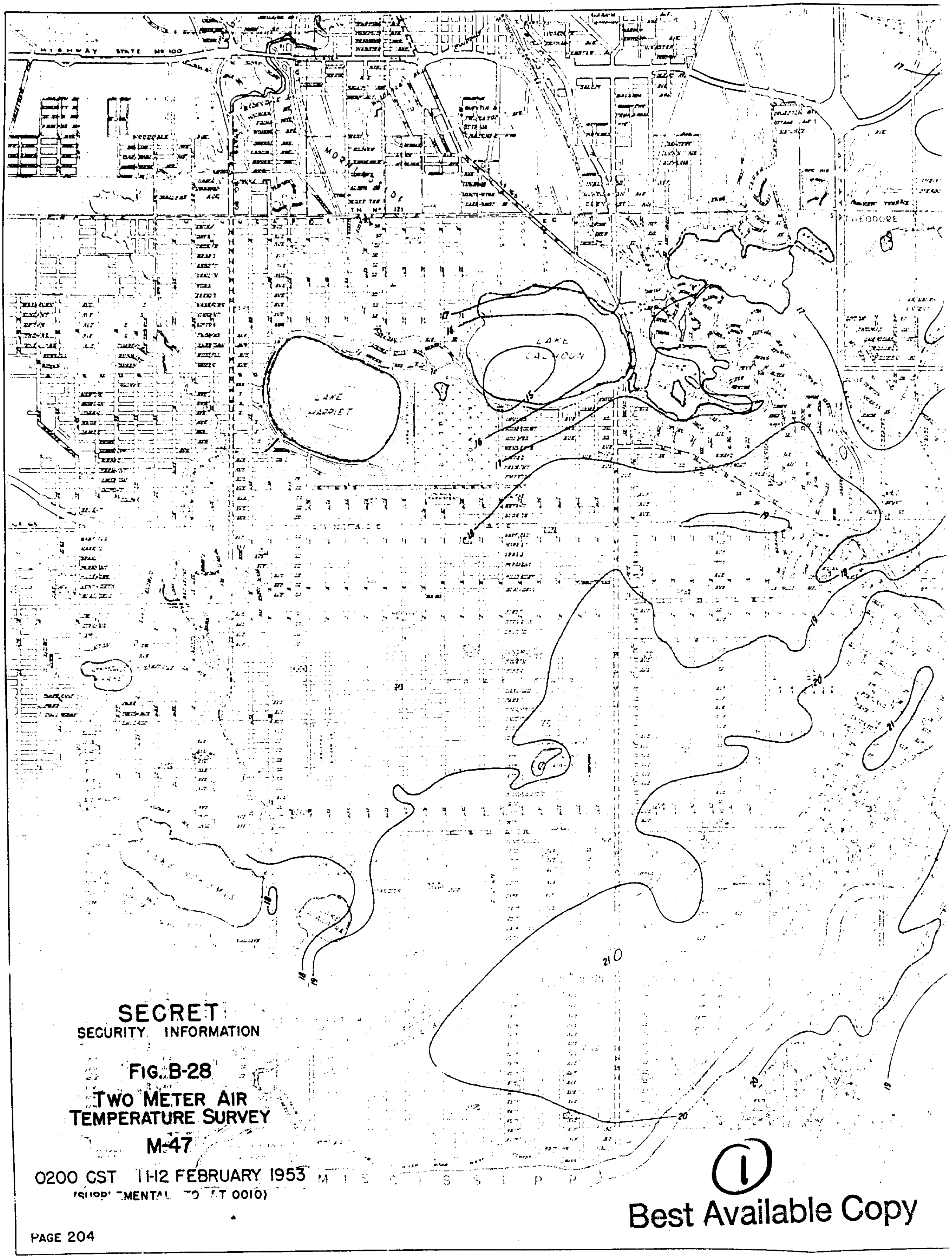
Mixing ratio of 2.1 gm/kgm dry air.



LOOKING WEST FROM LOCATION
OF AEROSOL GENERATION

SECRET
SECURITY INFORMATION

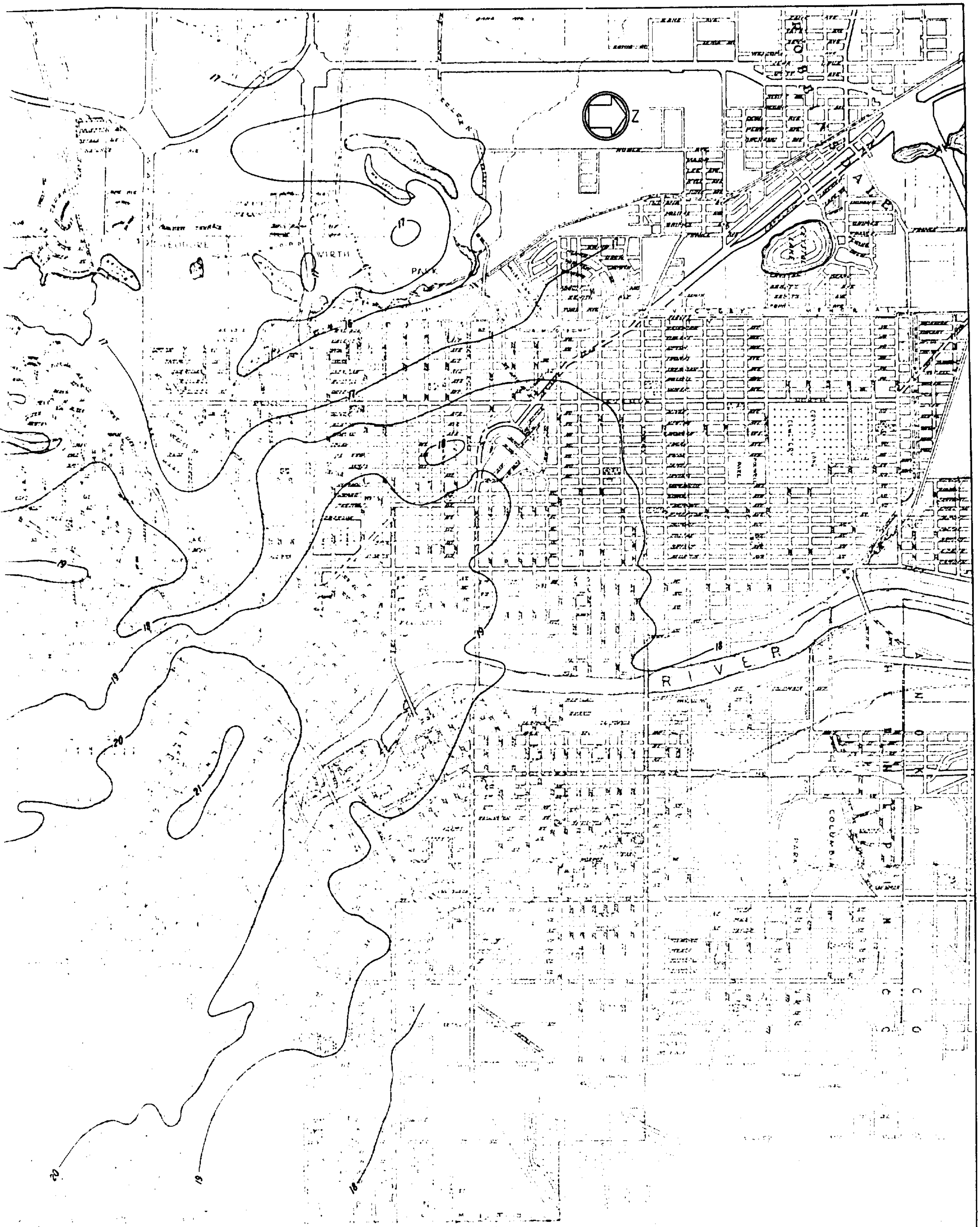
FIGURE B-27
TEST ARRAY AND RESULTS
FT 0009c 2305 CST
FEBRUARY 9, 1953



SECRET
SECURITY INFORMATION

FIG. B-28
TWO METER AIR
TEMPERATURE SURVEY
M-47

0200 CST 11-12 FEBRUARY 1953
(SUPPLEMENTAL TO ST 0010)



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2

SUMMARY OF REGIONAL AND LOCAL WEATHER

FT 0010 Survey M-47 11-12 Feb 1953

Synoptic Situation

A cold front had passed Minneapolis the night before leaving a 4" layer of snow. Another cold front was approaching from the northwest. This front did not pass the station until well after this test. Surface winds were generally from the northwest at 8 to 12 mph. 700 mb air flow was from the northwest at 25 mph.

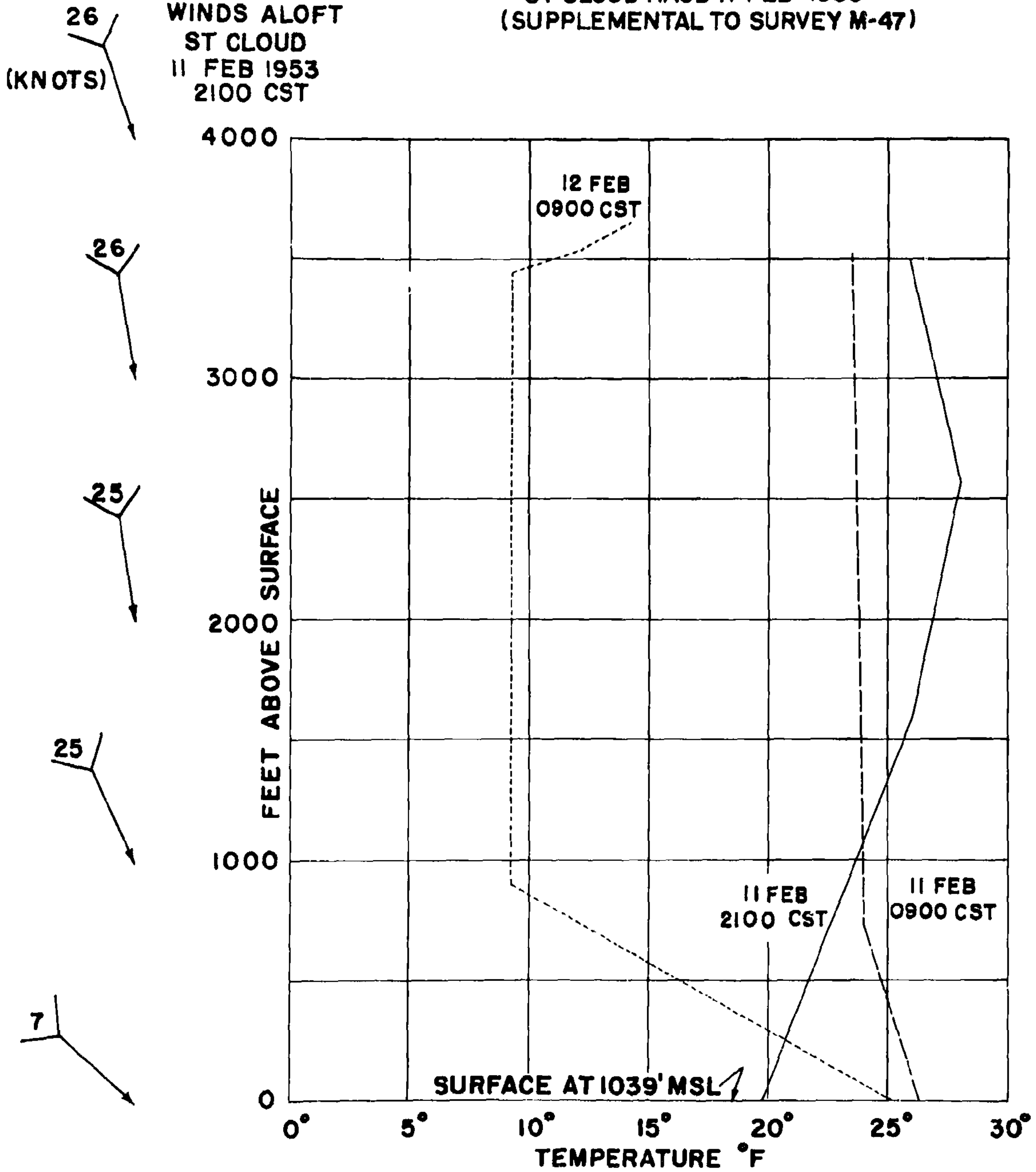
Weather Reports from Wold Chamberlain Field (Minneapolis)

Time CST	Cloud Height (feet)	Sky* Cover	Visibility (miles)	Weather**	Temp (°F)	Dew Point	Wind Dir	Wind Speed (mph)
2230		Clear	15+		22	19	WNW	10
2330		Clear	15+		20	16	W	7
0030		Clear	15+		19	15	NW	9
0130		Clear	15+		19	15	NW	8
0230		Clear	15+		18	14	WNW	7
0330	9000	Scat-tered	15+		18	14	NW	10
0430	3100	Over-cast	15+		20	17	NW	11
0530	3000	Over-cast	15+		20	17	WNW	8
0630	3300	Over-cast	15+		21	18	WNW	11

Sea level pressure at 0230 CST: 1015.6 mb
Ground condition: Packed snow with layer fresh snow on top Lakes were frozen
Tree cover: None
* Average cloudiness sunrise to sunset: 100%
** and/or restrictions to visibility

FIGURE B-29

TEMPERATURE SOUNDINGS
ST CLOUD RAOB 11 FEB 1953
(SUPPLEMENTAL TO SURVEY M-47)



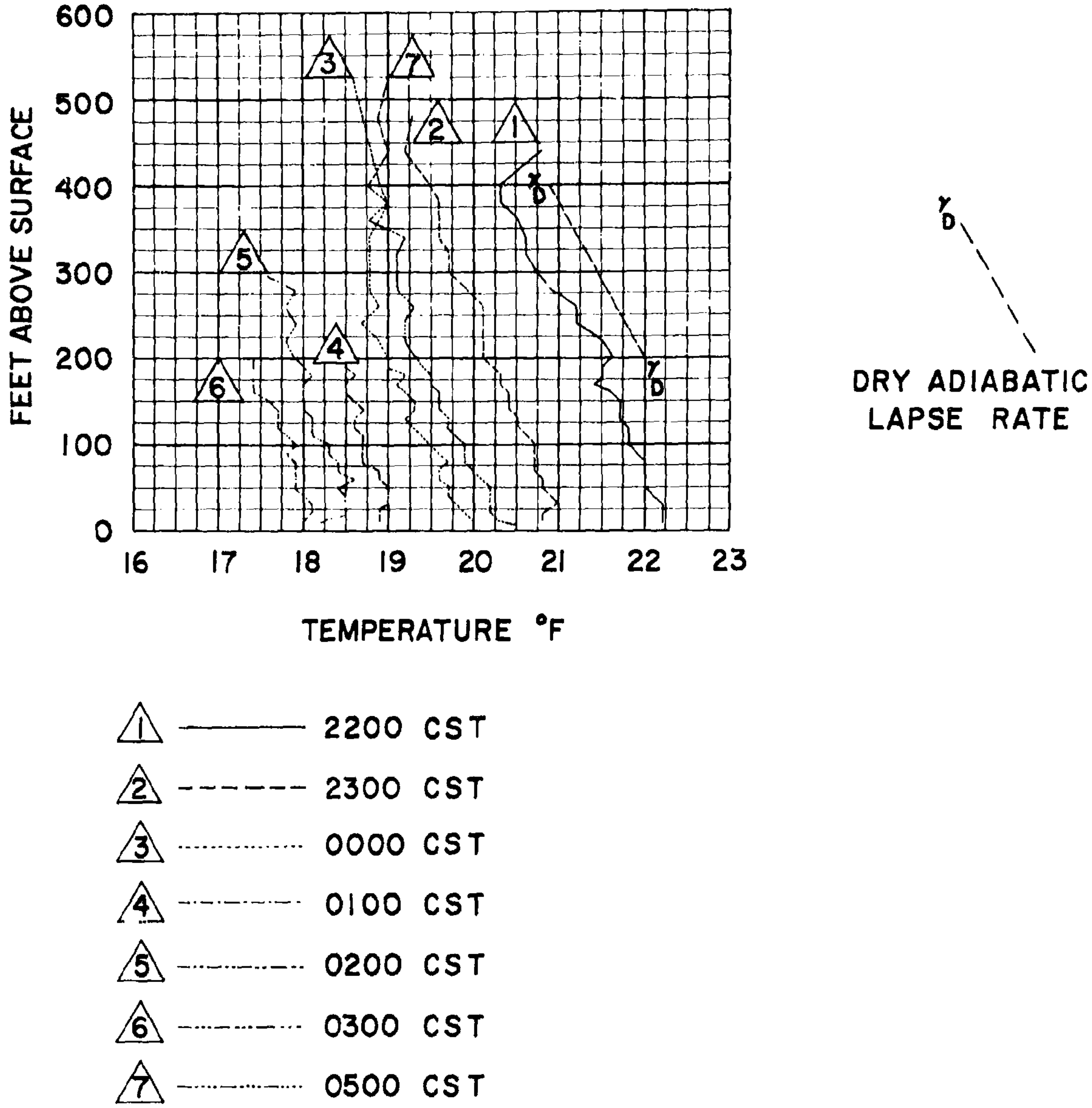


FIGURE B-30
TEMPERATURE SOUNDINGS
MINNEAPOLIS RESIDENTIAL
WIRESONDE
SURVEY M-47 11 FEB. 1953

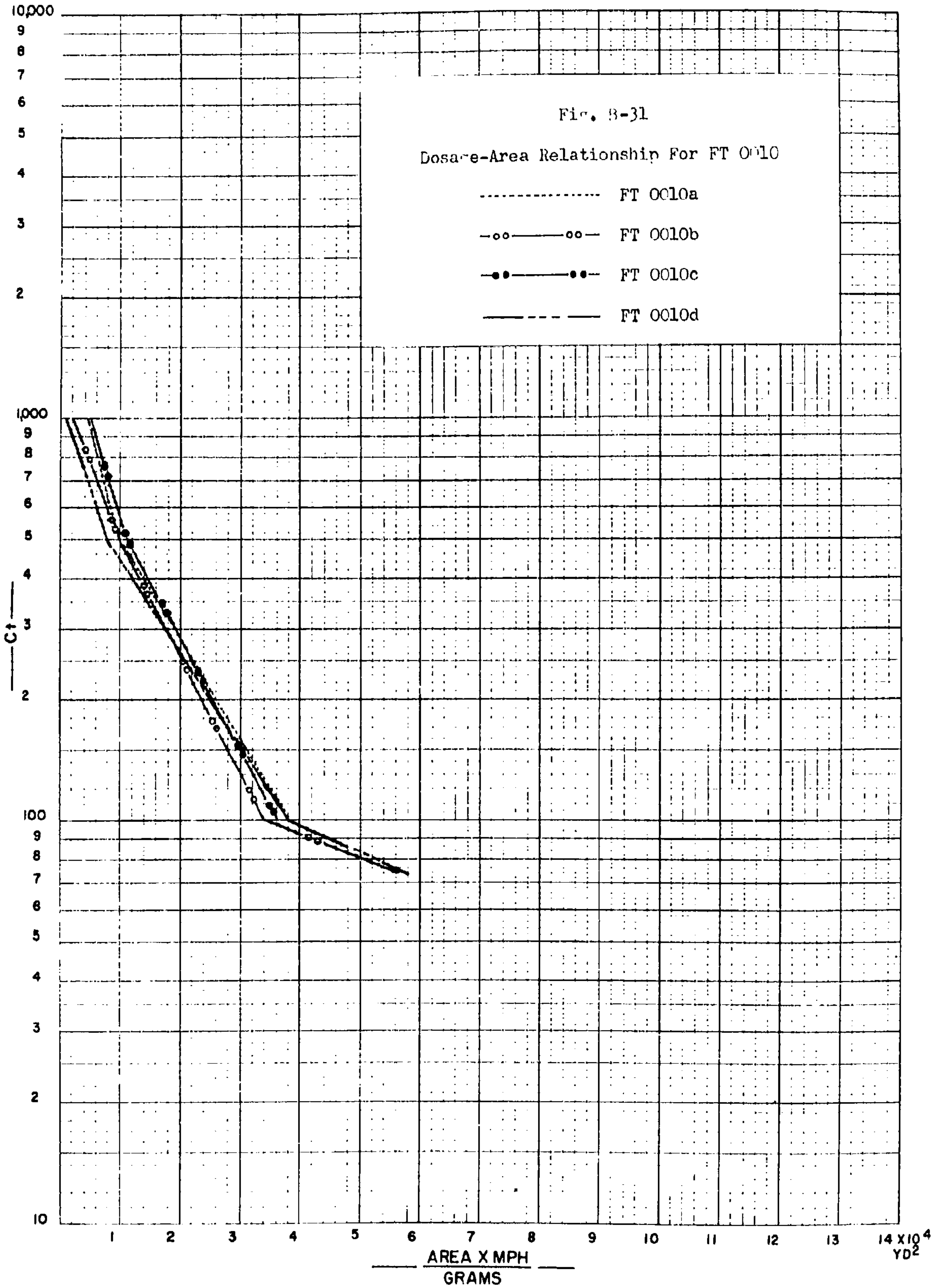


Fig. B-31

Dosage-Area Relationship For FT 0010

SUMMARY OF CLINTON SCHOOL DOSAGES*
FT 0010a**   12 February 1953

	Ground	Ground Floor	First Floor	Second Floor	Roof
Outside	192			303	244
					129
Inside		51	82	61	
		68	51	74	
		172			

* Dosages are expressed in particle-minutes per liter. When more than one sampler is involved, values are listed on separate lines.

** The sampler array for this and other tests is found in Figs. V-28 through V-31.

AEROSOL GENERATION

Point-source release of 13.3 gms of NJZ 2266 over a period of 5 minutes starting at 0020 CST from a roof-mounted blower disperser (30 feet above street level) located at point ✠.

SAMPLING

Location and Exposure

Membrane-filter sampling equipment located at 97 stations as shown on test-array map by following symbols:

● Outdoor sampler at height between 1 and 6 feet.

◒ Outdoor sampler at height above or below general terrain level as indicated by note.

○ Indoor sampler at location indicated by test-array map or text.

Results

All samplers operated to measure total dosages. In addition, samplers at selected stations were operated incrementally, as shown by the sampling period and the corresponding increment dosage given to the left of the station symbol.

Sampling Period	Increment Dosage		Total Dosage (particle-minutes/liter)
0015-0100 CST	50	● 58	T = trace dosage
0100-0135 CST	8		M = malfunction or data missing

100 — 100   Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as M1 and M2.

Similar observations at rooftop level (35 feet above surface, at NW corner of the school building) and wire-sonde ascents made at meteorological station M3.

2100 — 2105 — 2110   Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between the times indicated.

2145   Balloon track representing wind-drift observation at the time indicated.

Winds

Roof-level winds northwesterly at 6.0 mph; street-level winds northwesterly at 3.8 mph.

Stability

1.0° F. lapse from 6-300 ft.

Sky

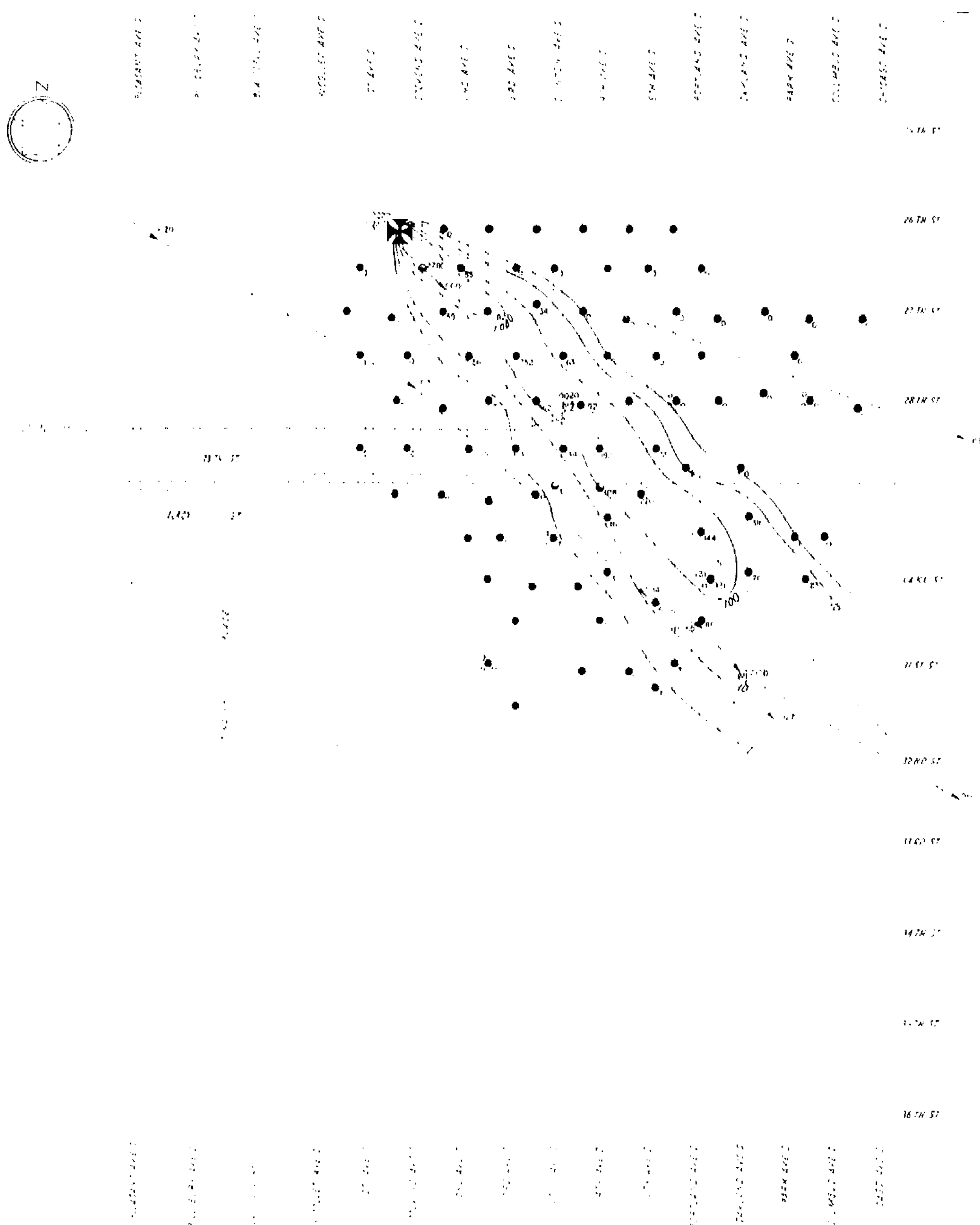
Clear at start of test period but becoming scattered at 0330 CST and low overcast at 0430; bases were 3000 ft above the surface.

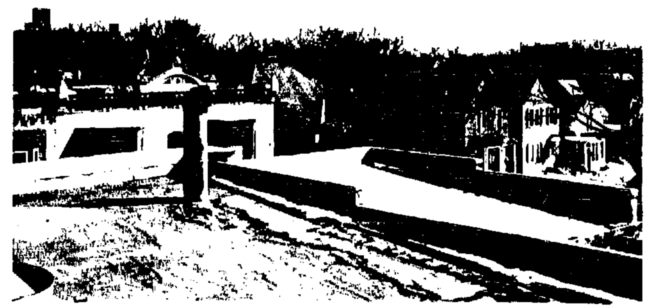
Temperature

18-20° F at 2 meters in the test area.

Moisture

Mixing ratio of 1.9 gm/kgm dry air.





LOOKING SOUTHEAST FROM ROOF TOP LOCATION OF AEROSOL GENERATION

SECRET
SECURITY INFORMATION

FIGURE B-32
TEST ARRAY AND RESULTS
FT 0010a 0020 CST
FEBRUARY 12, 1953

SUMMARY OF CLINTON SCHOOL DOSAGES*
FT 0010b**   12 February 1953

	Ground	Ground Floor	First Floor	Second Floor	Roof
Outside	96			61	32
					92
Inside		22	37	31	
		30	31	21	
		33			

* Dosages are expressed in particle-minutes per liter. When more than one sampler is involved, values are listed on separate lines.

** The sampler array for this and other tests is found in Figs. V-28 through V-31.

AEROSOL GENERATION

Point-source release of 12.1 gms of NJZ 2266 over a period of 5 minutes starting at 0140 CST from a vehicle-mounted blower dispersor located at point ✠.

SAMPLING

Location and Exposure

Membrane-filter sampling equipment located at 97 stations as shown on test-array map by following symbols:

● Outdoor sampler at height between 1 and 6 feet.

◒ Outdoor sampler at height above or below general terrain level as indicated by note.

○ Indoor sampler at location indicated by test-array map or text.

Results

All samplers operated to measure total dosages. In addition, samplers at selected stations were operated incrementally, as shown by the sampling period and the corresponding increment dosage given to the left of the station symbol.

Sampling Period	Increment Dosage	Total Dosage (particle-minutes per liter)
0135-0220 CST	50	T = trace dosage
0220-0300 CST	8 ● 58	M = malfunction or data missing.

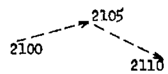
Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

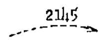
Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as M1 and M2.

Similar observations at rooftop level (35 feet above surface, at NW corner of the school building) and wiresonde ascents made at meteorological station M3.



Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between the times indicated.



Balloon track representing wind-drift observation at the time indicated.

Winds

Roof-level winds west-northwesterly at 8 mph; street-level winds northwesterly at 4 mph.

Stability

0.8° F lapse from 6-300 ft.

Sky

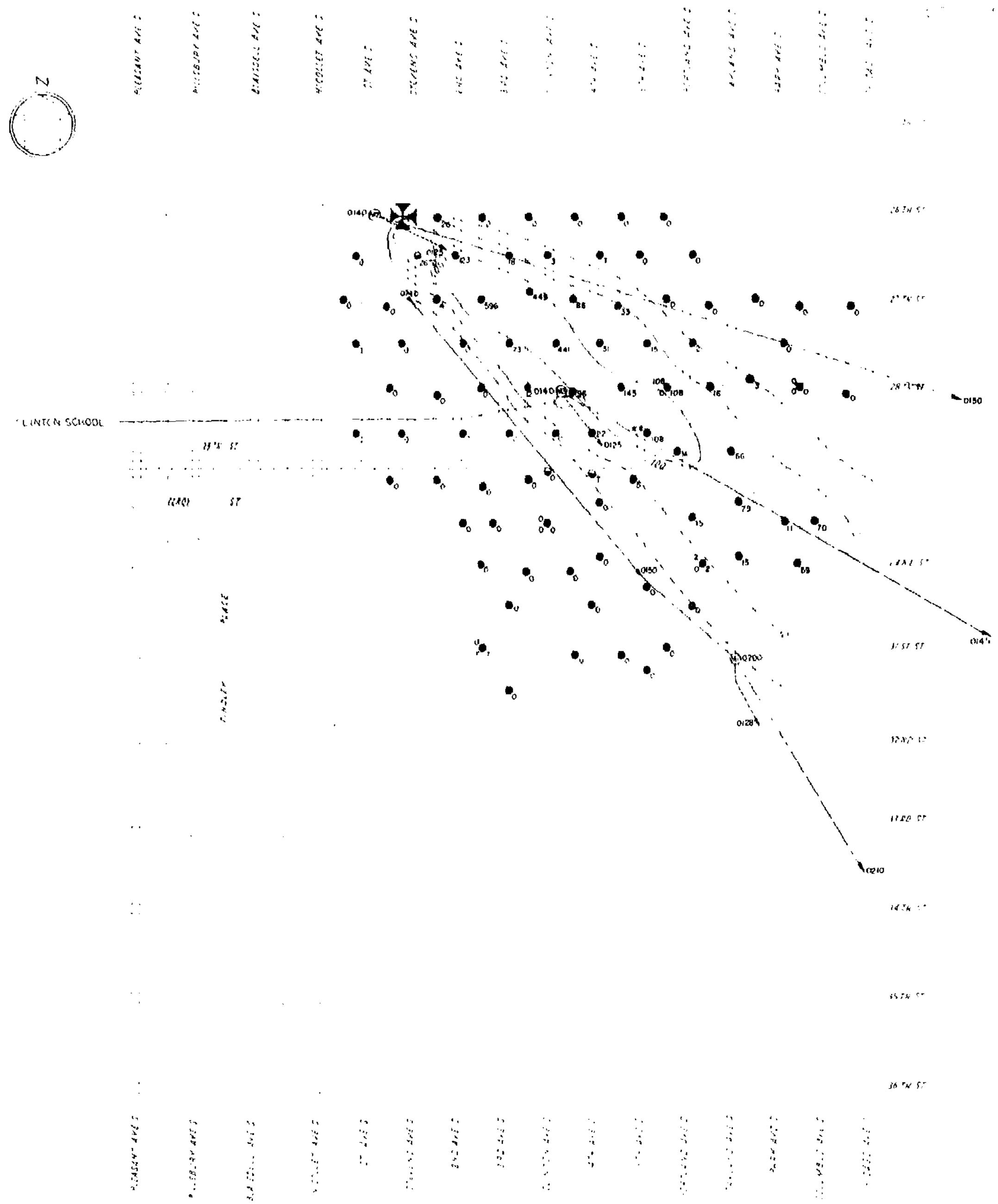
Clear at start of test period but becoming scattered at 0330 CST and low overcast at 0430; bases were 3000 ft above the surface.

Temperature

18-20° F at 2 meters in the test area.

Moisture

Mixing ratio of 1.9 gm/kgm dry air.



LOOKING SOUTHEAST FROM
LOCATION OF AEROSOL GENERATION

SECRET
SECURITY INFORMATION

FIGURE B-33
TEST ARRAY AND RESULTS
FT 0010b 0140 CST
FEBRUARY 12,1953

SUMMARY OF CLINTON SCHOOL DOSAGES*
FT 0010c** 12 February 1953

	Ground	Ground Floor	First Floor	Second Floor	Roof
Outside	181			208	93
					247
Inside		23	34	41	
		64	51	30	
		61			

* Dosages are expressed in particle-minutes per liter. When more than one sampler is involved, values are listed on separate lines.

** The sampler array for this and other tests is found in Figs. V-28 through V-31.

AEROSOL GENERATION

Point-source release of 11.5 gms of NJZ 2266 over a period of 5 minutes starting at 0305 CST from a vehicle-mounted blower disperser located at point ✠.

SAMPLING

Location and Exposure

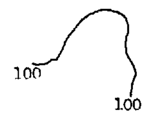
Membrane-filter sampling equipment located at 97 stations as shown on test-array map by following symbols:

- ● Outdoor sampler at height between 1 and 6 feet.
- ◒ Outdoor sampler at height above or below general terrain level as indicated by note.
- ○ Indoor sampler at location indicated by test-array map or text.

Results

All samplers operated to measure total dosages. In addition, samplers at selected stations were operated incrementally, as shown by the sampling period and the corresponding increment dosage given to the left of the station symbol.

Sampling Period	Increment Dosage		Total Dosage (particle-minutes per liter)
0300-0345 CST	50	● 58	T = trace dosage
0345-0420 CST	8		M = malfunction or data missing



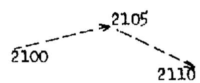
Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

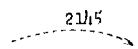
Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as M1 and M2.

Similar observations at rooftop level (35 feet above surface, at NW corner of the school building) and wiresonde ascents made at meteorological station M3.



Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between the times indicated.



Balloon track representing wind-drift observation at the time indicated.

Winds

Roof-level winds west-northwesterly at 4.5 mph; street-level winds west-northwesterly at 3.0 mph.

Stability

0.9° F lapse from 6-300 ft.

Sky

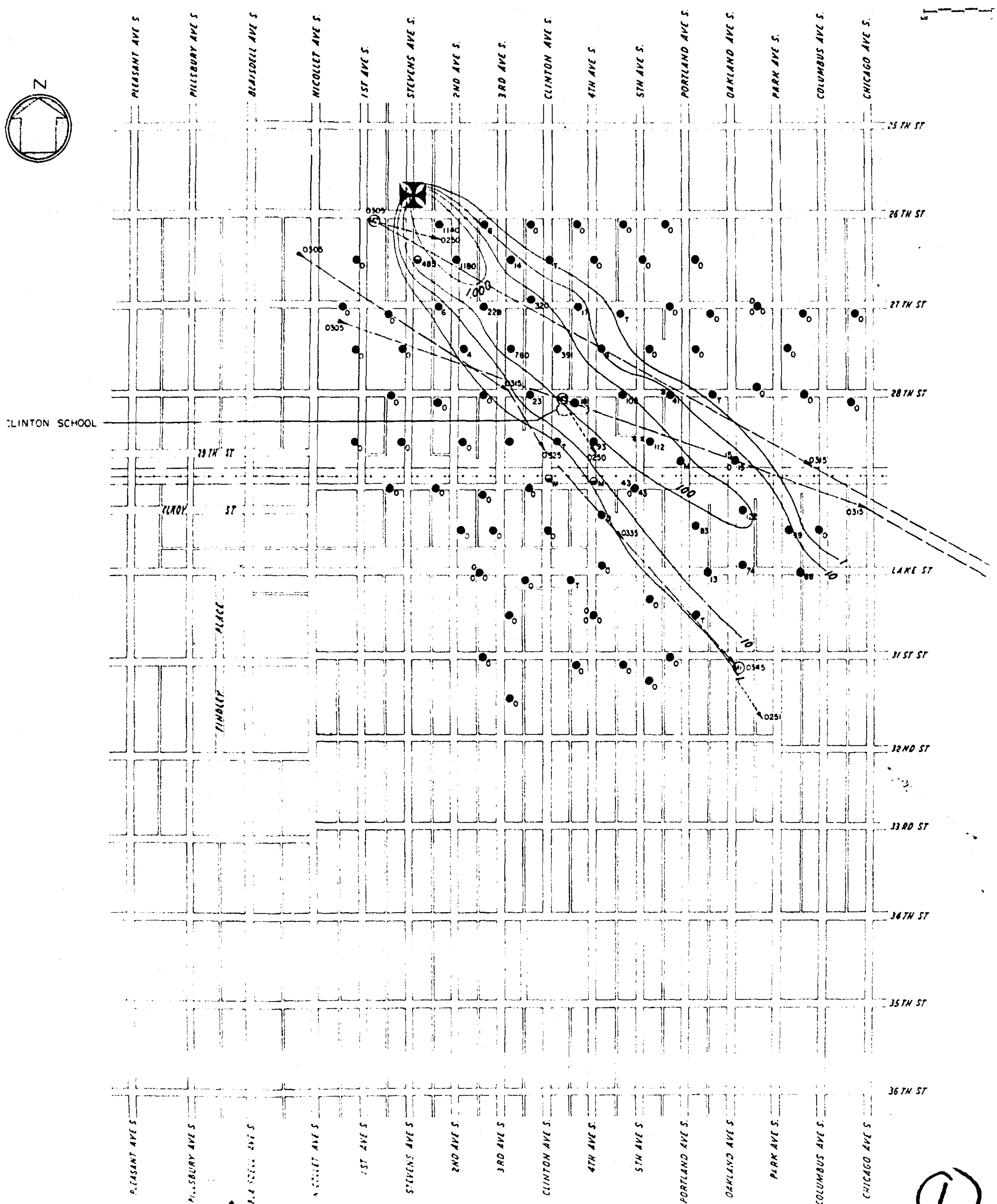
Clear at start of test period but becoming scattered at 0330 CST and low overcast at 0430; bases were 3000 ft above the surface.

Temperature

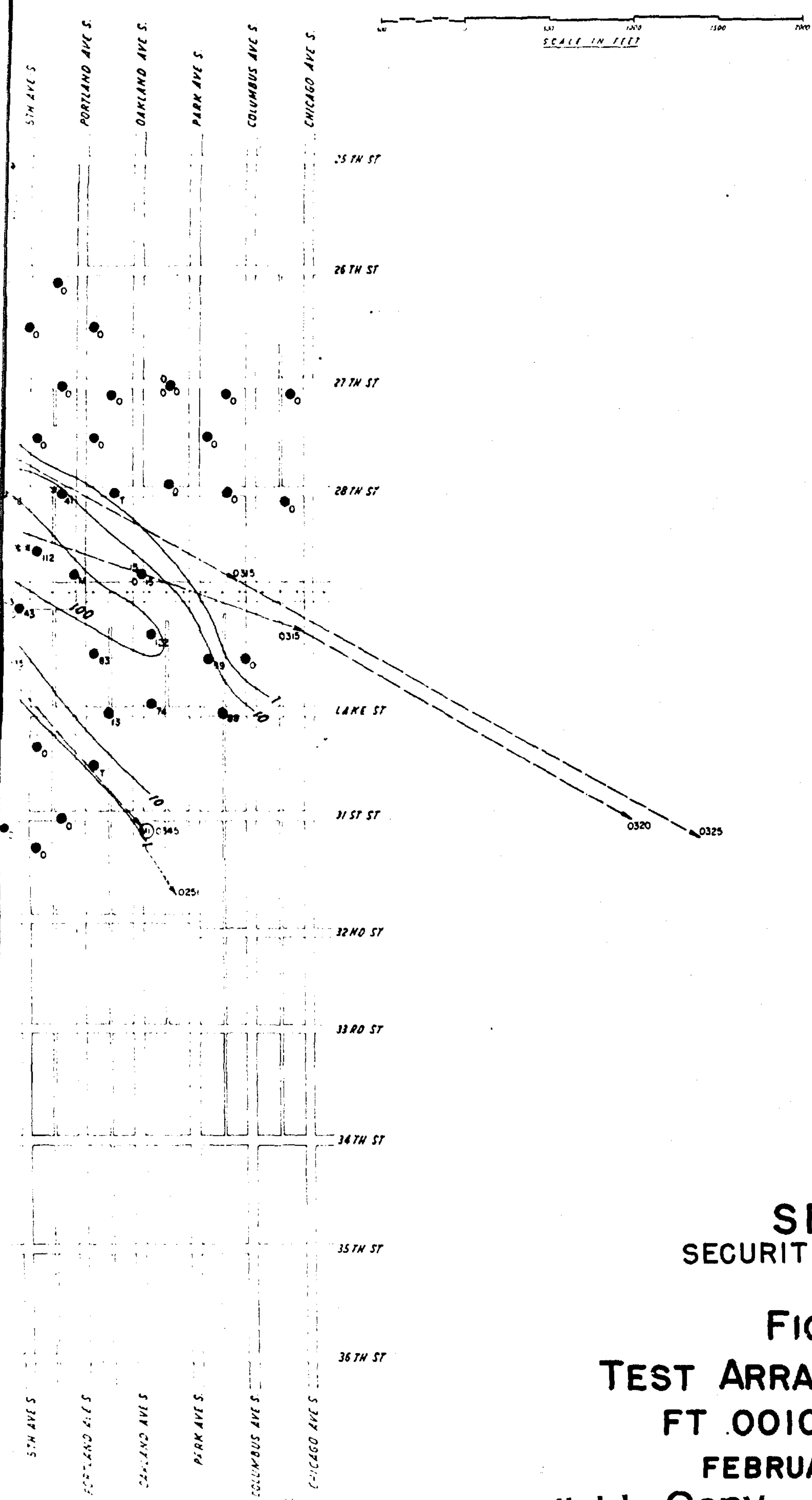
18-20° F at 2 meters in the test area.

Moisture

Mixing ratio of 1.9 gm/kgm dry air.


N
PLEASANT AVE S.
PILLSBURY AVE S.
BLAISDELL AVE S.
NICOLLET AVE S.
1ST AVE S.
STEVENS AVE S.
2ND AVE S.
3RD AVE S.
CLINTON AVE S.
4TH AVE S.
5TH AVE S.
PORTLAND AVE S.
OAKLAND AVE S.
PARK AVE S.
COLUMBUS AVE S.
CHICAGO AVE S.
25TH ST
26TH ST
27TH ST
28TH ST
29TH ST
ELROY ST
LAKE ST
31ST ST
32ND ST
33RD ST
34TH ST
35TH ST
36TH ST
FINDLEY PLACE
CLINTON SCHOOL
1000
100
10
1

1



SECRET
SECURITY INFORMATION

FIGURE B-34
TEST ARRAY AND RESULTS
FT 0010c 0305 CST
FEBRUARY 12, 1953

②

Best Available Copy

SUMMARY OF CLINTON SCHOOL DOSAGES*
FT 0010d**   12 February 1953

	Ground	Ground Floor	First Floor	Second Floor	Roof
Outside	223			163	93
					226
Inside		28	41	31	
		34	52	25	
		38			

* Dosages are expressed in particle-minutes per liter. When more than one sampler is involved, values are listed on separate lines.

** The sampler array for this and other tests is found in Figs. V-28 through V-31.

AEROSOL GENERATION

Point-source release of 12.2 gms of NJZ 2266 over a period of 5 minutes starting at 0425 CST from a vehicle-mounted blower disperser located at point ✠.

SAMPLING

Location and Exposure

Membrane-filter sampling equipment located at 97 stations as shown on test-array map by following symbols:

● Outdoor sampler at height between 1 and 6 feet.

◒ Outdoor sampler at height above or below general terrain level as indicated by note.

○ Indoor sampler at location indicated by test-array map or text.

Results

All samplers operated to measure total dosages. In addition, samplers at selected stations were operated incrementally, as shown by the sampling period and the corresponding increment dosage given to the left of the station symbol.

Sampling Period	Increment Dosage		Total Dosage (particle-minutes per liter)
0420-0505 CST	50	● 58	T = trace dosage
0505-0520 CST	8		M = malfunction or data missing

100 100 Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as M1 and M2.

Similar observations at rooftop level (35 feet above surface, at NW corner of the school building) and wiresonde ascents made at meteorological station M3.

2100 2105 2110 Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between the times indicated.

2145 Balloon track representing wind-drift observation at the time indicated.

Winds

Roof-level winds north-northwesterly at 2.0 mph; street-level winds northwesterly at 3.2 mph.

Stability

1.3° F lapse from 6-300 ft.

Sky

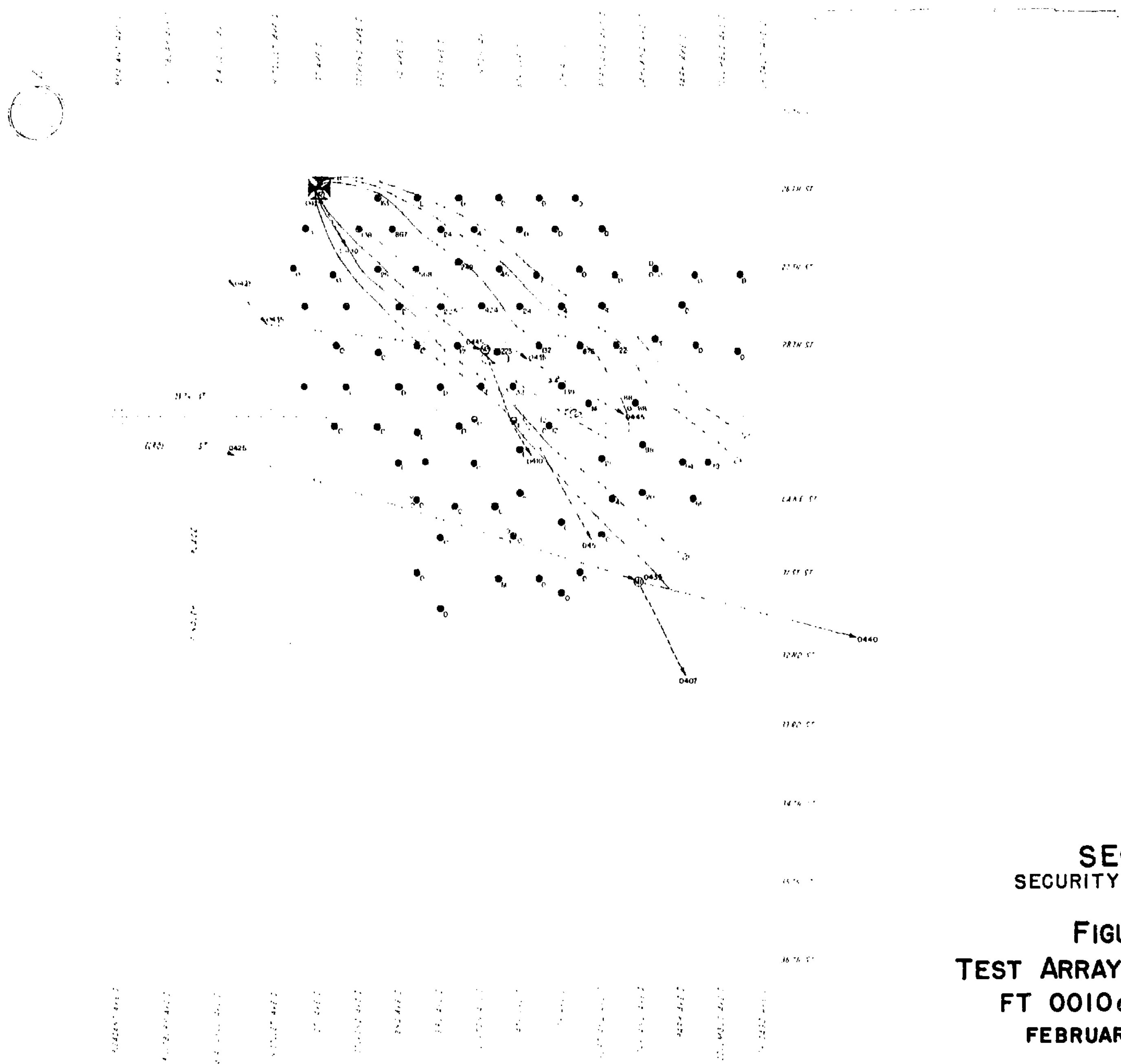
Clear at start of test period but becoming scattered at 0330 CST and low overcast at 0430; bases were 3000 ft above the surface.

Temperature

18-20° F at 2 meters in the test area.

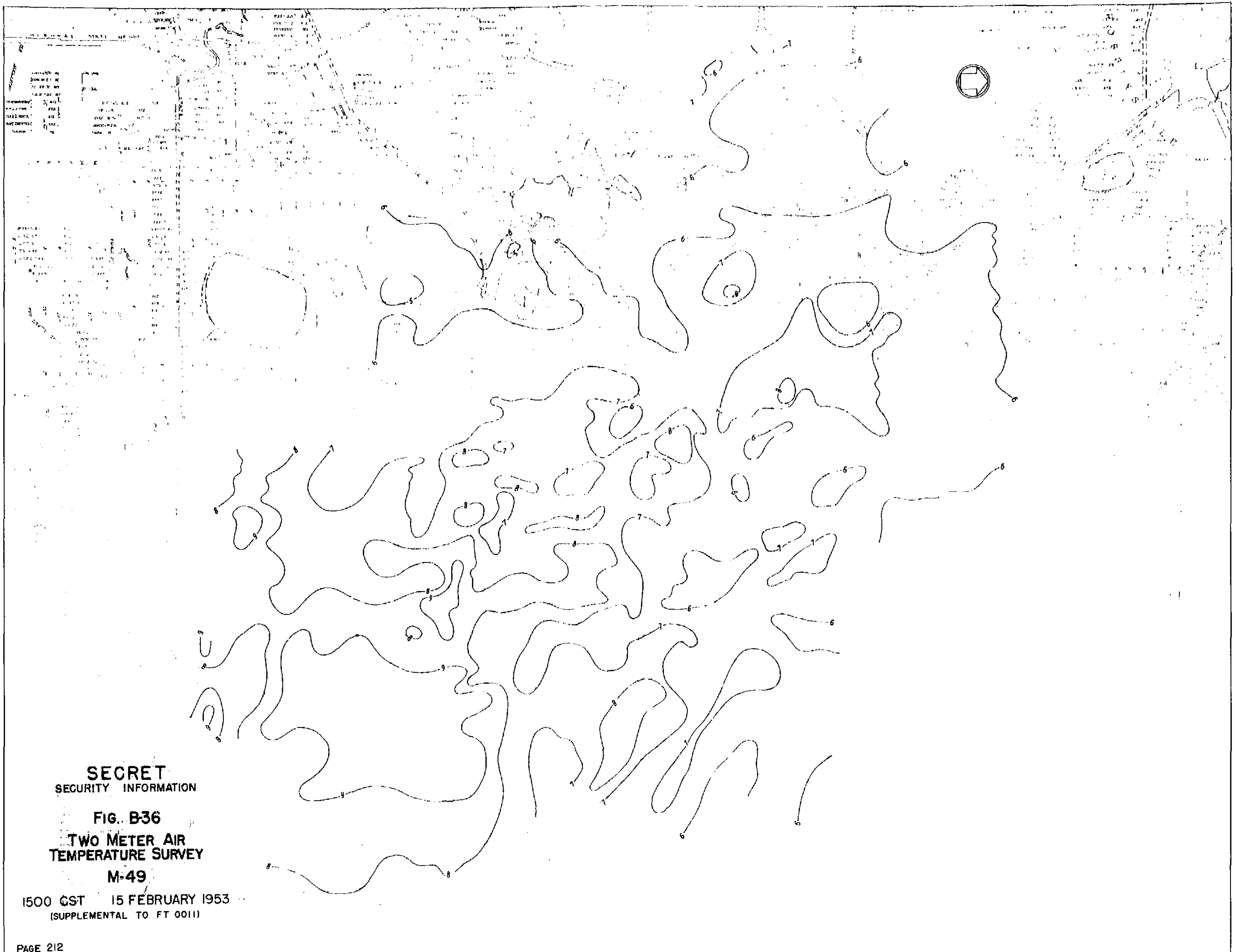
Moisture

Mixing ratio of 1.9 gm/kgm dry air.



SECRET
SECURITY INFORMATION

FIGURE B-35
TEST ARRAY AND RESULTS
FT 0010d 0425 CST
FEBRUARY 12, 1953



SECRET
SECURITY INFORMATION

FIG. B-36
TWO METER AIR TEMPERATURE SURVEY
M-49

1500 CST 15 FEBRUARY 1953
(SUPPLEMENTAL TO FT 0011)

SUMMARY OF REGIONAL AND LOCAL WEATHER

FT 0011   Survey M-49   15 Feb 1953

Synoptic Situation

The closest front to Minneapolis was a warm front 350 miles to the south which extended through northern Missouri. A deepening low with pressure 1001 mb was associated with this frontal system. An arctic high with pressure 1029 mb was located over Saskatchewan. This high was the dominating weather influence in Minnesota. Surface wind flow was northwesterly at 8 to 12 mph. Air flow at 700 mb was from the northwest at 50 mph.

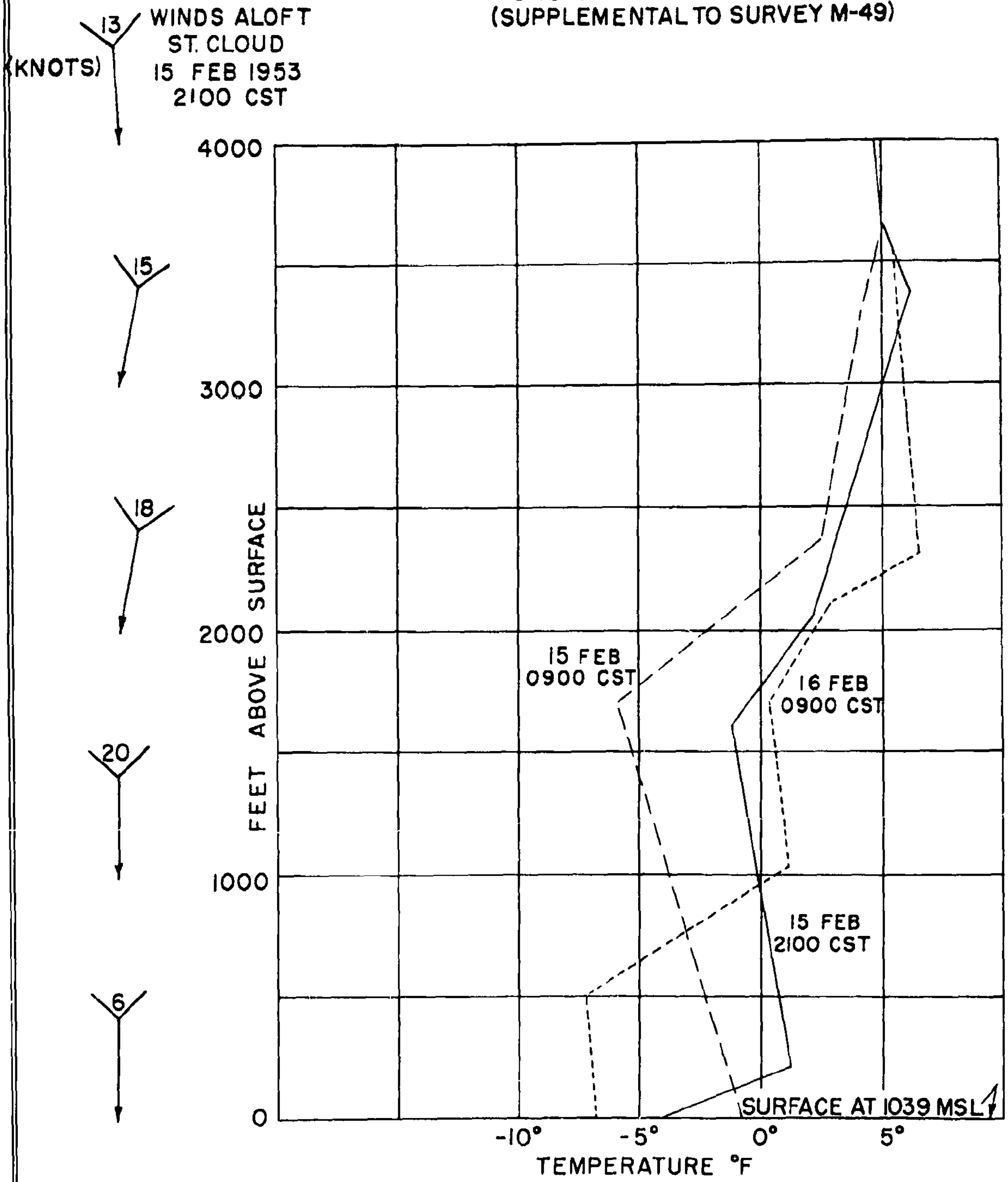
Weather Reports from Wold Chamberlain Field (Minneapolis)

Time CST	Cloud Height (feet)	Sky* Cover	Visibility (miles)	Weather**	Temp (°F)	Dew Point	Wind Dir	Wind Speed (mph)
1330	25,000	Scattered	15		8	-7	NW	9
1430	25,000	Scattered	15		10	-5	NW	11
1530	25,000	Scattered	15		10	-5	NW	10
1630	25,000	Scattered	15		8	-5	NNW	10
1730	25,000	Scattered	15		7	-8	NNW	10
1830	25,000	Clear	15		5	-10	NNW	6
1930	25,000	Clear	15		1	-10	WNW	8

Sea level pressure at 1630 CST: 1014.6 mb
Ground Condition: Streets clear   4" packed snow on ground   Lakes frozen
Tree Cover: None
* Average cloudiness sunrise to sunset: 10%
** and/or restrictions to visibility

FIGURE B-37

TEMPERATURE SOUNDINGS
ST. CLOUD RAOB 15 FEB 1953
(SUPPLEMENTAL TO SURVEY M-49)



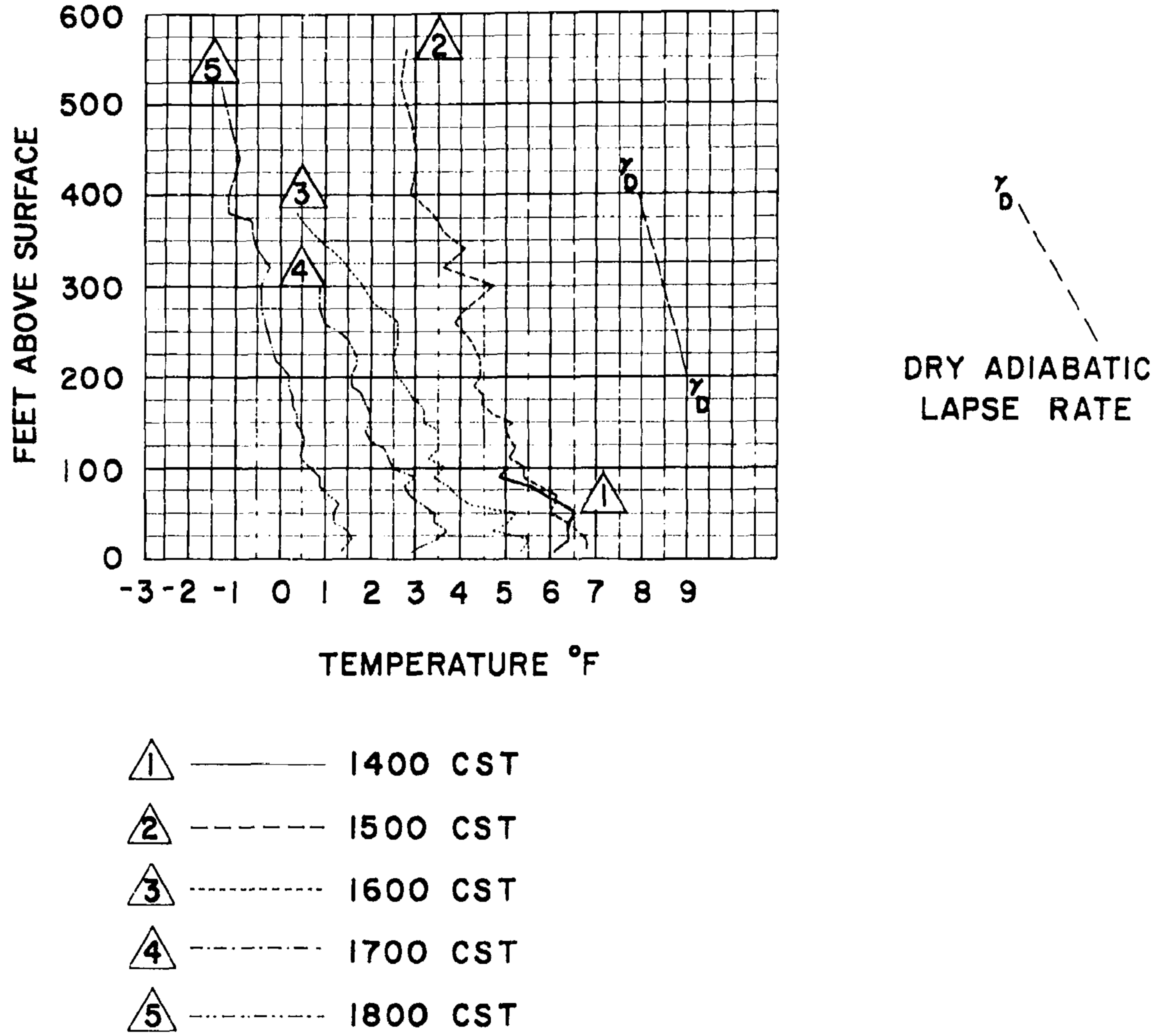


FIGURE B-38
TEMPERATURE SOUNDINGS
MINNEAPOLIS RESIDENTIAL
WIRESONDE
SURVEY M-49 15 FEB. 1953

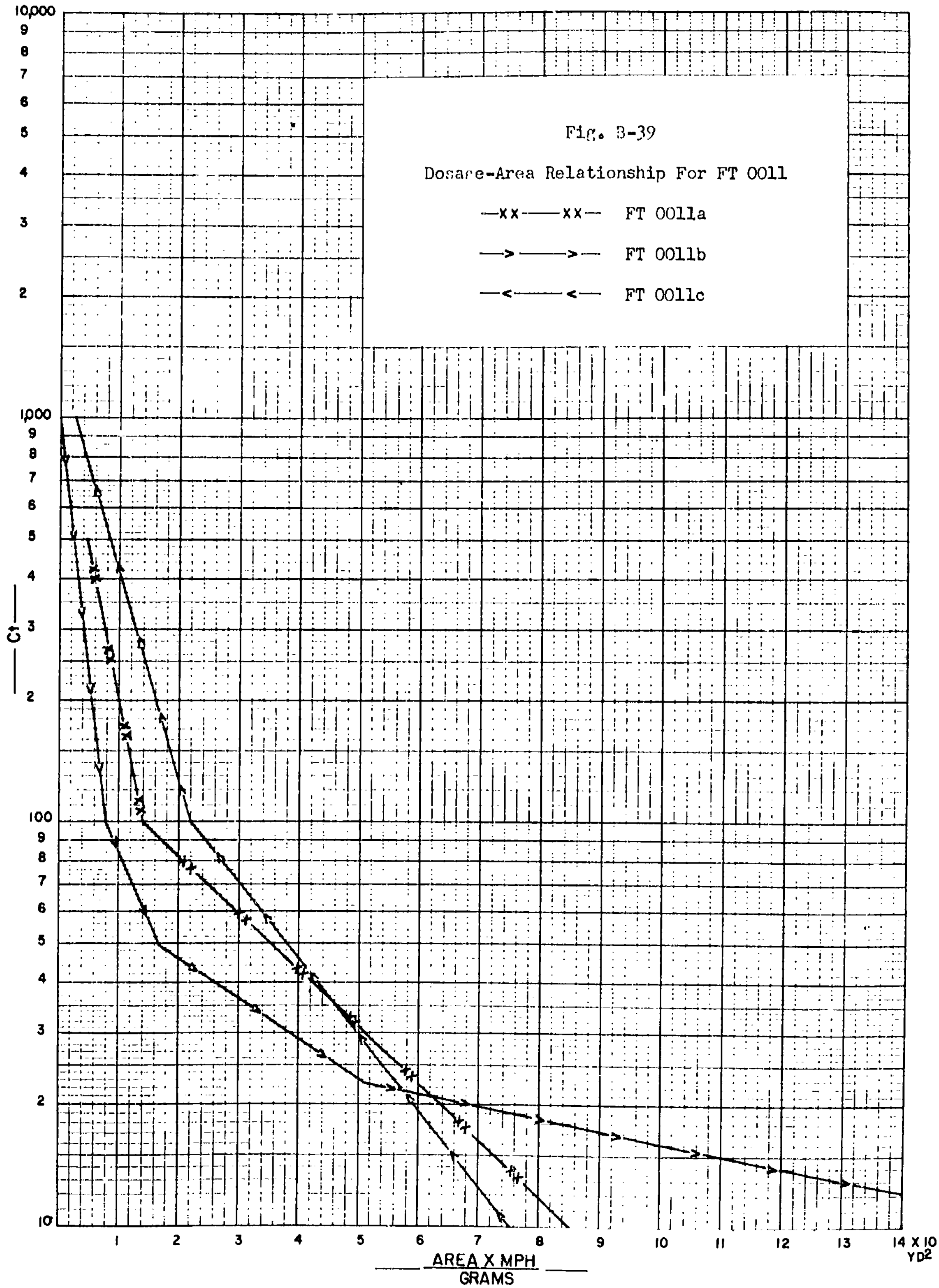


Fig. B-39
Dosage-Area Relationship For FT 0011
FT 0011a
FT 0011b
FT 0011c
10,000
1,000
100
10
Ct
1 2 3 4 5 6 7 8 9 10 11 12 13 14 X 10^4 YD^2
AREA X MPH
GRAMS

SUMMARY OF HOUSE-PENETRATION AND CLINTON SCHOOL DOSAGES*
FT 0011a 15 February 1953

RESIDENCES**

House	Outside	Basement	First Floor	Second Floor
E	643	341 30	302 18	218 27
		284 12		

CLINTON SCHOOL***

	Ground	Ground Floor	First Floor	Second Floor	Roof
Outside	8		8 T		7
			11 T		11
Inside		T 8		3 T	
		3 T		6 2	
		4 3			

* Dosages are expressed in particle-minutes per liter; T represents trace dosage, i.e., a count not exceeding 15 fluorescent particles. When more than one sampler is involved, values are listed on separate lines. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units.

** Individual residences are described in Section V-E. With the illustration of a given house (see Figs. V-23 through V-27) is given the summary of all dosages obtained at that house.

*** The sampler array for this and other tests is found in Figs. V-28 through V-31.

AEROSOL GENERATION

Point-source release of 11.8 gms of NJZ 2266 over a period of 5 minutes starting at 1405 CST from a roof-mounted blower disperser (35 feet above street level) located at point ✠ .

SAMPLING

Location and Exposure

Membrane-filter sampling equipment located at 96 stations as shown on test-array map by following symbols:

● Outdoor sampler at height between 1 and 6 feet.

◓ Outdoor sampler at height above or below general terrain level as indicated by note.

○ Indoor sampler at location indicated by test-array map or text.

Results

All samplers operated to measure total dosages. In addition, samplers at selected stations were operated incrementally, as shown by the sampling period and the corresponding increment dosage given to the left of the station symbol.

Sampling Period	Increment Dosage		Total Dosage (particle-minutes per liter)
1400-1445 CST	50	● 58	T = trace dosage
1445-1530 CST	8		N = malfunction or data missing

100 100 Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as M1 and M2 .

Similar observations at rooftop level (35 feet above surface) and wiresonde ascents made at meteorological station M3 .

2100 2105 2110 Virtual wind track, with length (drawn to map scale) and direction of each arrow representing the virtual wind travel between the times indicated.

2145 Balloon track representing wind-drift observation at the time indicated.

Winds

Roof-level winds westerly at 5.0 mph; street-level winds west-northwesterly at 3.7 mph.

Stability

3.0° F lapse from 6-300 ft.

Sky

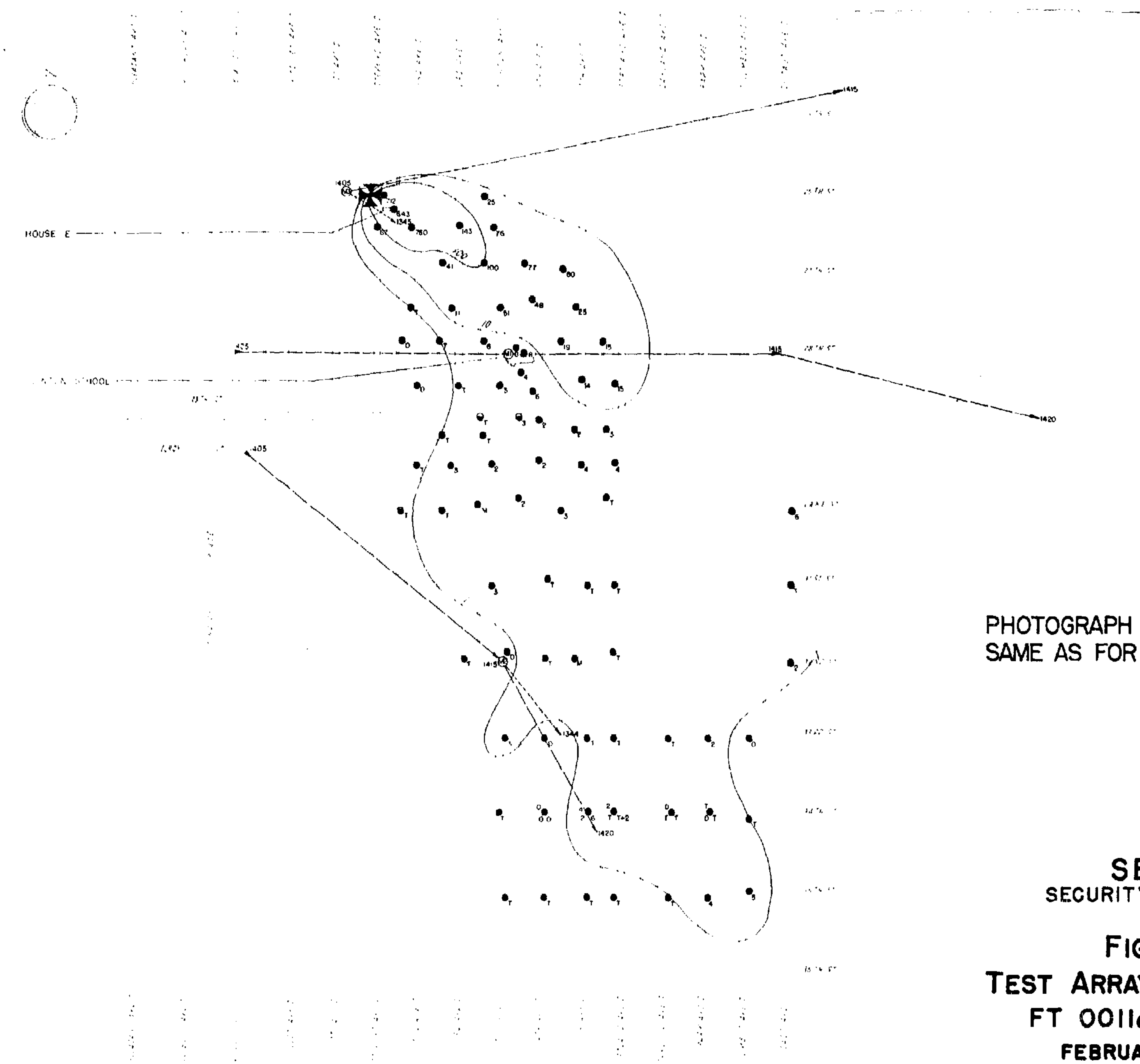
High scattered clouds with base over 20,000 ft. from the surface.

Temperature

3-7° F at 2 meters in the test area.

Moisture

Mixing ratio of 0.7 gm/kgm dry air.



PHOTOGRAPH OF RELEASE POINT
SAME AS FOR FT-0010a, FIG. B-32

SECRET
SECURITY INFORMATION

FIGURE B-40
TEST ARRAY AND RESULTS
FT 0011a 1405 CST
FEBRUARY 15, 1953

SUMMARY OF HOUSE-PENETRATION AND CLINTON SCHOOL DOSAGES*
FT 0011b 15 February 1953

RESIDENCES**

House	Outside	Basement	First Floor	Second Floor
E	1040	475 11	708 32	409 36
		506 14		

CLINTON SCHOOL***

	Ground	Ground Floor	First Floor	Second Floor	Roof
Outside	41		41 17	36	23
			31 T		36
Inside		6 2		5 8	
		19 10		6 4	
		23 T			

* Dosages are expressed in particle-minutes per liter; T represents trace dosage, i.e., a count not exceeding 15 fluorescent particles. When more than one sampler is involved, values are listed on separate lines. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units.

** Individual residences are described in Section V-E. With the illustration of a given house (see Figs. V-23 through V-27) is given the summary of all dosages obtained at that house.

*** The sampler array for this and other tests is found in Figs. V-28 through V-31.

AEROSOL GENERATION

Point-source release of 11.6 gms of NJZ 2266 over a period of 5 minutes starting at 1535 CST from a roof-mounted blower disperser (35 feet above street level) located at point ✠.

SAMPLING

Location and Exposure

Membrane-filter sampling equipment located at 96 stations as shown on test-array map by following symbols:

● Outdoor sampler at height between 1 and 6 feet.

◒ Outdoor sampler at height above or below general terrain leves as indicated by note.

○ Indoor sampler at location indicated by test-array map or text.

Results

All samplers operated to measure total dosages. In addition, samplers at selected stations were operated incrementally, as shown by the sampling period and the corresponding increment dosage given to the left of the station symbol.

Sampling Period

1530-1615 CST
1615-1655 CST

Increment Dosage

50
8 ● 58

Total Dosage (particle-minutes per liter)

T = trace dosage
M = malfunction or data missing

100 100

Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as M1 and M2.

Similar observations at rooftop level (35 feet above surface) and wiresonde ascents made at meteorological station M3.

2105
2100 2110

Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between the times indicated.

2145

Balloon track representing wind-drift observations at the times indicated.

Winds

Roof-level winds west-northwesterly at 5.0 mph; street-level winds north-northwesterly at 3.9 mph.

Stability

3.3° F lapse from 6-300 ft.

Sky

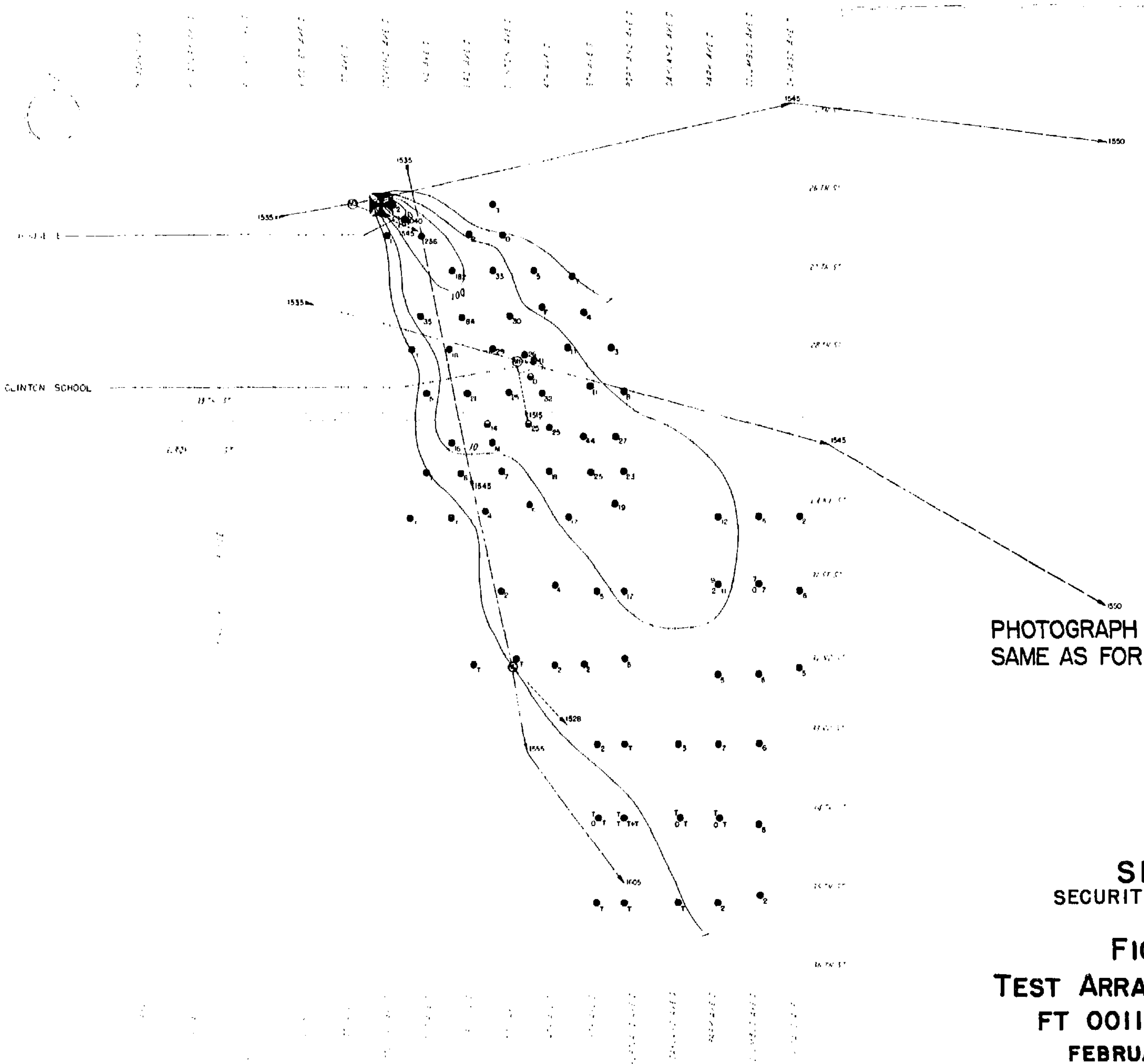
High scattered clouds with base over 20,000 ft. above the surface.

Temperature

3-7° F at 2 meters in the test area.

Moisture

Mixing ratio of 0.7 gm/kgm dry air.



PHOTOGRAPH OF RELEASE POINT
SAME AS FOR FT-0010a, FIG. B-32

SECRET
SECURITY INFORMATION

FIGURE B-41
TEST ARRAY AND RESULTS
FT 0011b 1535 CST
FEBRUARY 15, 1953

SUMMARY OF HOUSE-PENETRATION AND CLINTON SCHOOL DOSAGES*
FT 0011c 15 February 1953

RESIDENCES**

House	Outside	Basement	First Floor	Second Floor
E	1970	996 25	1060 54	750 63
		851 48		

CLINTON SCHOOL***

	Ground	Ground Floor	First Floor	Second Floor	Roof
Outside	12		19 T	7	4
			T 4		T
Inside		2 T		4 T	
		7 3		2 T	
		5 T			

* Dosages are expressed in particle-minutes per liter; T represents trace dosage, i.e., a count not exceeding 15 fluorescent particles. When more than one sampler is involved, values are listed on separate lines. Double entries for a given column represent incremental dosages obtained with sequentially exposed filter units.

** Individual residences are described in Section V-E. With the illustration of a given house (see Figs. V-23 through V-27) is given the summary of all dosages obtained at that house.

*** The sampler array for this and other tests is found in Figs. V-28 through V-31.

AEROSOL GENERATION

Point-source release of 10.9 gms of NJZ 2266 over a period of 5 minutes starting at 1710 CST from a vehicle-mounted blower disperser located at point ✠ .

SAMPLING

Location and Exposure

Membrane-filter sampling equipment located at 96 stations as shown on test-array map by following symbols:

● Outdoor sampler at height between 1 and 6 feet.

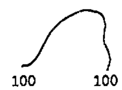
◐ Outdoor sampler at height above or below general terrain level as indicated by note.

○ Indoor sampler at location indicated by test-array map or text.

Results

All samplers operated to measure total dosages. In addition, samplers at selected stations were operated incrementally, as shown by the sampling period and the corresponding increment dosage given to the left of the station symbol.

Sampling Period	Increment Dosage		Total Dosage (particle-minutes per liter)
1700-1745 CST	50	● 58	T = trace dosage
1745-1800 CST	8		M = malfunction or data missing



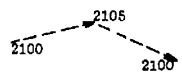
Dosage contour with values expressed in particle-minutes per liter.

METEOROLOGY

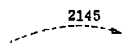
Equipment and Measurement

At street level, wind direction continuously recorded, and air and surface temperatures, wind velocity, and other meteorological observations taken at stations designated as (M1) and (M2) .

Similar observations at rooftop level (35 feet above surface) and wiresonde ascents made at meteorological station (M3) .



Virtual wind track, the length (drawn to map scale) and direction of each arrow representing the virtual wind travel between the times indicated.



Balloon track representing wind-drift observation at the time indicated.

Winds

Roof-level winds northwesterly at 4 mph; street-level winds north-northwesterly at 3 mph.

Stability

2.2° F lapse from 6-300 feet.

Sky

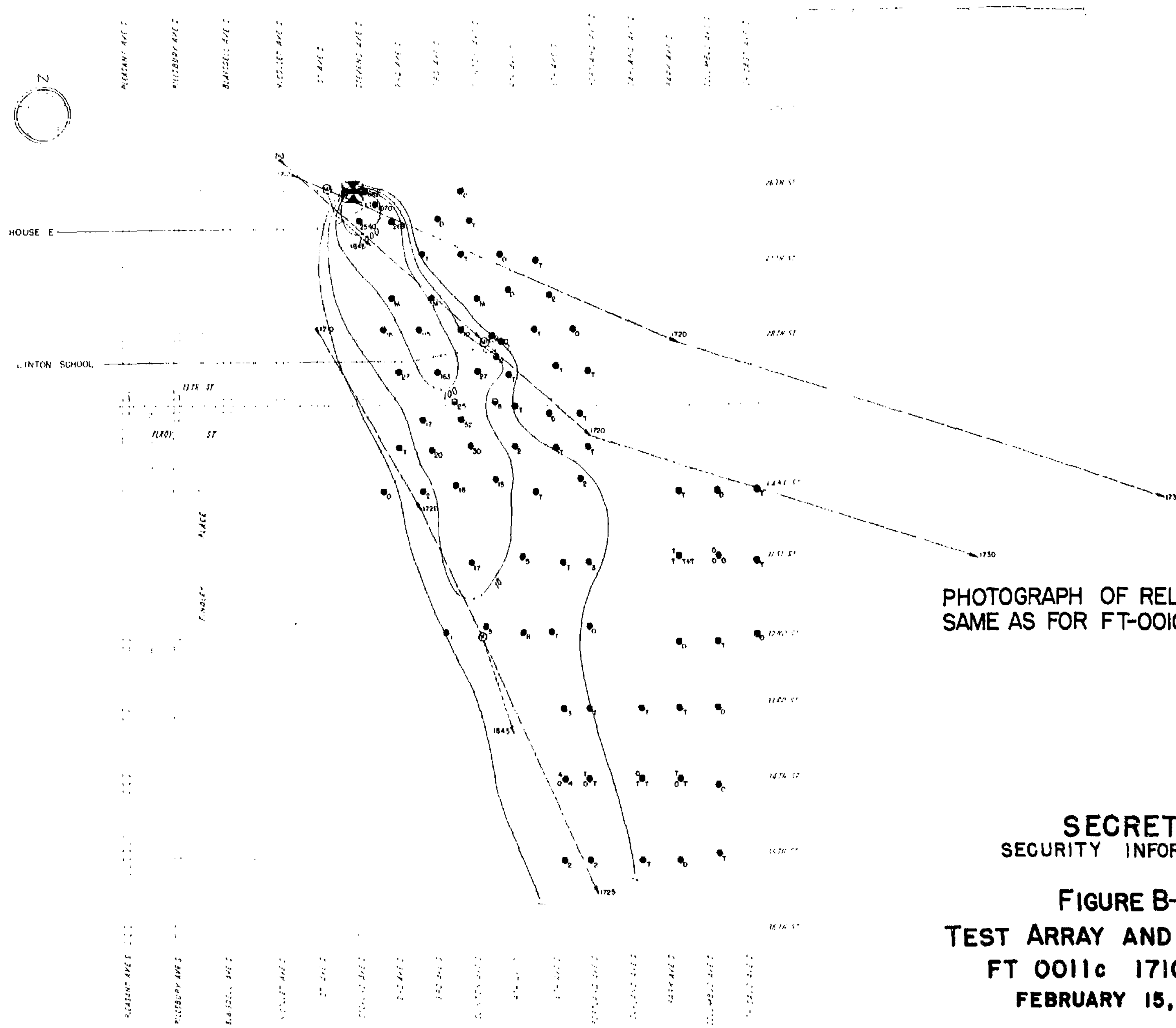
High scattered clouds with base over 20,000 ft. above the surface.

Temperature

3.7° F at 2 meters in the test area.

Moisture

Mixing ratio of 0.7 gm/kgm dry air.



PHOTOGRAPH OF RELEASE POINT
SAME AS FOR FT-0010b, FIG. B-33

SECRET
SECURITY INFORMATION

FIGURE B-42
TEST ARRAY AND RESULTS
FT 0011c 1710 CST
FEBRUARY 15, 1953